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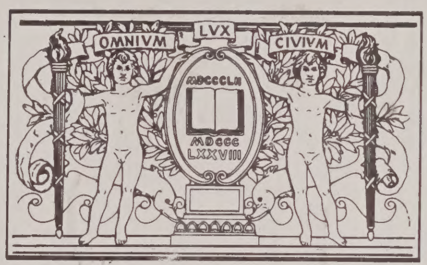

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CITY OF BOSTON, MASSACHUSETTS

REPORT ON IMPROVEMENTS TO THE BOSTON MAIN DRAINAGE SYSTEM

VOLUME 1

HUD Project No. P-Mass-3306

SEPTEMBER, 1967

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September 28, 1967

Commissioner John F. Flaherty
Public Works Department
5th Floor, City Hall Annex
Boston, Massachusetts 02108

Report on Improvements
to the Boston Main
Drainage System
HUD Project No. P-Mass-3306
CDM 257-12R

Dear Commissioner Flaherty:

In accordance with the terms of our contract with the City of Boston dated February 10, 1966, we have conducted an engineering investigation of the Boston Main Drainage System. The results of our investigation, together with cost estimates and recommendations, are presented in detail in the report which is transmitted herewith. The report is in two volumes. Volume 1 contains the results of our studies and recommendations, and Volume 2 contains the several appendices. A summary of this report is presented below.

Summary

The City of Boston comprises most of Suffolk County and is located along the lower reaches of the Charles, Mystic and Neponset Rivers on Massachusetts Bay. It covers a total land area of about 45 square miles and the city limits extend eastward in Massachusetts Bay to the limit of United States territorial waters.

The City in 1960 was the center of the sixth largest populated area in the United States. As a large metropolitan center its population consists of three significant components; residential, worker and transient. We estimate that the present residential population of the city (640,000) will increase to about 850,000 by the year 2020. The average estimated worker and transient population is expected to increase from about 550,000 at present to about 800,000 by the year 2020.

The Boston Main Drainage System receives sewage from an area in Boston, Quincy and Milton of about 10,800 acres with a present estimated residential population of about 300,000 which is expected to increase to about 400,000 by the year 2020. This area,

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The Boston Main Drainage System includes about 24 miles of intercepting sewers and about 7 miles of trunk sanitary sewers directly connected to the MDC Sewerage System. The principal components of this system are the Boston Main Interceptor, five branch interceptors, and the outlet works. The five branch interceptors are the East Side Interceptor, West Side Interceptor, South Boston Interceptor, Dorchester Interceptor and Stony Brook Interceptor.

Efforts were made to conduct a photographic inspection of this system to determine the structural conditions of the conduits. However, such inspection could not be accomplished because of continuously surcharged conditions in the interceptors. As a result,available photographic evidence and visual inspection at manholes were utilized for evaluation and design.

Water Quality in Boston Harbor

In June, 1967 the waters of Boston Harbor and those of the Charles River, Neponset River and Mystic River as well as other waters in the Commonwealth were classified based upon water quality standards adopted by the Massachusetts Division of Water Pollution Control on March 3, 1967. Waters into which overflows discharge are classified B, SB, C and SC. Based upon our investigations and analyses of samples taken at various points around Boston Harbor and the Charles River Basin, it appears at this time, to be no less expensive to provide facilities to meet Class C and SC requirements than to meet the higher Class B and SB requirements, so far as mixed sewage and storm water overflows are concerned. We conclude that if harbor and adjacent waters are to be made suitable for proposed uses, the solution must include the elimination of such overflows.

Alternative Methods of Pollution Abatement

We have studied four principal alternative methods of pollution abatement for Boston Harbor and adjacent waters. The four methods are: (1) complete separation of all sanitary sewerage and storm drainage systems, (2) construction of chlorination detention tanks, (3) construction of surface holding tanks, and (4) construction of the Deep Tunnel Plan.

We estimate that the construction cost of the Deep Tunnel Plan will be about 430 million dollars and that the capitalized annual operation and maintenance costs will be about 66 million dollars, or a total for comparison purposes of 496 million dollars. This compares with total estimated costs of 584 million dollars for complete separation, 533 million dollars for chlorination detention tanks and 814 million dollars for holding tanks. These estimated costs are based upon facilities required to serve the Boston region consisting of Boston and the neighboring communities of Brookline, Cambridge, Chelsea and Somerville, each of which have extensive combined sewer systems. The construction cost of a Deep Tunnel Plan to serve the City of Boston alone is estimated at 300 million dollars. However, in our opinion, it is not reasonable to expect the City of Boston alone to completely dispose of its mixed sewage and storm water overflows unless neighboring cities and towns having similar combined systems and overflow problems do likewise. For this reason, the proposed Deep Tunnel Plan should be constructed as a regional operation.

We recommend the Deep Tunnel Plan as the most positive method of collecting and disposing of overflows of mixed sewage and storm water. With this method all flows of mixed sewage and storm water from Boston and the region, including flows in excess of those resulting from the greatest recorded 24 hour rainfall which has occurred in Boston, may be disposed of well off-shore in Massachusetts Bay. The pollution of Boston Harbor and adjacent waters by such flows will then be eliminated. No alternative method studied provides this degree of mixed sewage and storm water disposal.

Proposed Deep Tunnel Plan

This plan will involve the construction of large deep rock storage tunnels, shafts, transmission tunnels, surface connections, a main pumping station located on Deer Island, and an ocean outfall and diffuser pipes.

It is essential that the City of Boston take the initiative in making the proposed Deep Tunnel Plan become a reality. To implement this plan, we recommend that the City initiate efforts for the region to obtain funds to defray the cost of further engineering investigations and planning for such a system. In addition, we recommend that the City join together with other major cities in the United States having similar problems in an effort to obtain the substantial financial assistance from government sources necessary to effect pollution abatement by this method.

Proposed Improvements to Existing Boston Sewerage System

In addition to the Deep Tunnel Plan which affects other municipalities in the region, it will be necessary to make improvements to the Boston system. We recommend the construction of sanitary sewers and storm conduits wherever existing principal conduits do not provide adequate capacity to carry estimated year 2020 peak design flows or runoff from 15 year frequency design rainstorms. Recommended improvements have been arranged in two programs; the "Initial Construction Program" and the Future Construction Program". The Initial Construction Program is of greater urgency than the Future Construction Program because of structural conditions evidenced by failures which have occurred in existing sewers, and in addition, the facilities which are affected by the initial program are the most important parts of the existing system located in the core area of the city and along the most heavily utilized beach areas in the city.

The recommended Initial Construction Program consists of three stages as follows:

Main Interceptor
Dorchester Brook Dry Weather Connection
Massachusetts Avenue Sewers
Mt. Vernon Street Sewers
East Side Interceptor - Roxbury Canal Branch
Improvements to Outlets and Appurtenant Facilities
Estimated Construction Cost - $15,050,000

South Boston Pollution Control Conduit
Carson Beach Pumping Station
South Boston Force Main
Estimated Construction Cost - $15,400,000

East Side Interceptor
Atlantic Avenue to Union Park Street
Estimated Construction Cost - $7,400,000

The estimated total construction cost of the Initial Construction Program is 37,850,000 dollars.

Facilities included in the recommended Future Construction Program are estimated to have a total construction cost of 118,900,000 dollars. We recommend the construction of these facilities as soon as possible after construction of the Initial Construction Program inasmuch as deficiencies exist in many areas served by facilities affected by this program.

Improvements to existing outlets (including tide gates) and appurtenant facilities not included in the initial program are recommended in the future program. Such improvements will serve to reduce the volume of tide water entering the sewerage system, reduce the degree of surcharging in existing sewers, and in addition reduce the volume of tide water reaching the MDC facilities.

Proposed facilities included in the Initial and Future Construction Programs are designed to complement the proposed Deep Tunnel Plan.

Summarizing, in addition to the estimated cost of the Deep Tunnel Plan (430 million dollars regional and 300 million dollars for the City alone), the Initial Construction Program will cost an estimated 37,850,000 dollars and the Future Construction Program 118,900,000 dollars.

Financing the Recommended Initial Construction Program

We estimate that approximately 22,740,000 dollars of the total cost of the recommended Initial Construction Program will be eligible for 25 per cent State and 50 per cent Federal grants. Thus it is expected that State and Federal grants will total about 17,050,000 dollars. The remaining 20,800,000 dollars must, therefore, be financed by the City. We estimate that if the City's share is financed by 30 year general obligation bonds, the total annual cost for the first year would be 1,525,000 dollars. If, in addition, the annual costs are met by general taxation, the first-year increase in the property tax rate would be $0.99 per $1,000 assessed valuation based on the announced 1967 real and personal property valuation of 1,531,000,000 dollars.

The Metropolitan Sewerage System

We have studied the effect of the MDC sewerage construction program on the Boston Main Drainage System. It appears that there is not appreciable effect on the existing surcharging of the Boston Main Drainage System as a result of diversions made to date into the MDC Ward Street Headworks. Until such time as recommended improvements of outlets and appurtenant facilities have been made, we would expect substantial surcharging to continue.

When tide water is eliminated from the Boston Main Drainage System, the facilities built as part of the MDC construction program, when in full operation, will receive only sewage flows during dry weather. During wet weather and for periods of time after storms, surcharging conditions will still occur, and discharges of mixed sewage and storm water to the surrounding waters will continue to occur. Because of these conditions, we expect little or no overall improvement of water quality in Boston Harbor and adjacent waters until the proposed Deep Tunnel Plan becomes a reality.

We have studied all existing connections from the City of Boston to MDC and the current assessment practice. We consider the present MDC estimates of total initial demand-capacity (494 mgd) and prorated demand-capacity (419 mgd) to be reasonable inasmuch as the peak dry weather rate of sewage flow from the city at present is about 282 mgd and in the year 2020 is estimated to be about 498 mgd.

The recommended Initial Construction Program will result in an estimated increase in the initial demand-capacity of about 14 mgd. The demand-capacity is used by the MDC to compute assessments to the City. If, however in addition, the Dorchester High Level Sewer Connection at River Street is replaced as we recommend, the increase in capacity would be reduced from 14 to about 2 mgd. Therefore, if all recommended construction is accomplished, we would expect very little increase in total initial demand-capacity.

In November 1966, Boston was assessed about 1,150,000 dollars which represented about 18.14 per cent of the total yearly MDC sewerage system assessment for principal and interest on serial bonds required for construction. When the four diversions are made from the Boston Main Drainage System, Boston's share will reportedly increase to about 38 per cent of the total assessment, based upon the computed prorated demand-capacity of connections, or about 2,410,000 dollars.

Acknowledgments

We wish to express our appreciation to you and your staff for the cooperation and assistance given us during the preparation of this report and to Mr. Edward G.A. Powers, Deputy Commissioner and Division Engineer, Sewer Division for his valued counsel. We gratefully acknowledge the cooperation of officials of the Boston Redevelopment Authority, Metropolitan District Commission and the Metropolitan Area Planning Council. We also acknowledge, with thanks, the assistance of the Massachusetts Department of Public Health, the Massachusetts Division of Water Pollution Control, Massachusetts Department of Public Works, the New England Division Corps of Engineers, and the U.S. Geological Survey, Engineering Geology Branch in Boston.

Very truly yours,

CAMP, DRESSER & McKEE

Charles A. Parthum

Charles A. Parthum

REPORT ON IMPROVEMENTS TO THE BOSTON MAIN DRAINAGE SYSTEM

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I SCOPE OF REPORT

This report on improvements to the Boston Main Drainage System has been prepared in accordance with the terms of a contract between the City of Boston and Camp, Dresser & McKee dated February 10, 1966 and has been financed by an interest-free advance to the City by the United States Department of Housing and Urban Development (HUD), HHFA Project No. P-Mass-3306. Under the terms of the contract Camp, Dresser & McKee is to provide engineering services "without duplicating work performed by or for the Boston Redevelopment Authority, for an engineering investigation and report on improvements; to the Boston Main Interceptor that is in need of major repairs or replacement; for replacement or relief of the East Side Interceptor which becomes overloaded; for the construction of a marginal conduit, pumping station; and outfall sewer to eliminate the overflow in South Boston."

In recent years, two sections of the Boston Main Interceptor have collapsed requiring extensive repair operations.

The East Side Interceptor is frequently surcharged indicating that relief or replacement may be required. Discharges from this interceptor into Boston Harbor and Fort Point Channel result in unsanitary conditions.

The area around Carson Beach, South Boston is subjected to pollution due to the discharge of mixed sewage and storm water into Old Harbor. The frequent surcharging of the South Boston Interceptor (South Branch) and the discharge of raw sewage in the beach areas results in unsanitary conditions.

This report includes, but is not limited to, the following items of work:

1. Preparation of a detailed plan showing locations, sizes and directions of flow of the sewers in the existing drainage system making full use of data previously collected by the City on sections of the system.

2. Study of the present and estimated future land uses, to establish populations and water requirements, used as a basis for estimating sewage flows. Evaluation of water consumption data with consideration given to its use. Estimates of the quantity of storm water runoff reaching the various portions of the system, based upon the rational method of analysis for storms of various intensities.

3. Determination of flows in key manholes of main sewers in order to measure infiltration, dry weather flow, storm water flow, the effect of tidewater flooding through existing overflow structures and the variations in flow.

4. Estimation of the amount of present and future sanitary, industrial and storm water flows for each of the drainage areas.

5. Investigation of the capacity and condition of all existing trunks, mains, and submains and their adequacy to service each watershed, based on the estimated future flows determined under 4. above.

6. Evaluation of the effect of the Metropolitan District Commission's sewer construction program on the Boston system, and make detailed recommendations to the City in connection therewith.

7. Investigation of the condition of all overflow structures insofar as possible, and compute their capacity; and recommendations of construction work required in connection therewith.

8. Determination of the basis to be utilized in each combined sewerage system so that the discharge from that system can be most efficiently given the treatment that might be necessary. Determination of which of the following alternatives, if any, are in the best interests of the City:

    (1) Separate each combined sewer system into independent sanitary and storm sewer systems.

    (2) Instead of separating the combined sewers, construct interceptors with detention basins located at points of interception of combined sewage to temporarily store peak flows until they can be carried by the downstream collection works.

    (3) In place of separating the combined sewers, construct interceptors for dry weather flows and locate chlorination stations at points of overflow to chlorinate all flows in excess of dry weather flow before they are bypassed to the receiving waters.

9. Obtain borings and subsurface explorations where information is not available to assist in arriving at the most feasible locations for recommended facilities, and to provide more reliable data for estimating costs.

10. Preparation of preliminary plans showing all proposed modifications, additions, relocations and replacements.

11. Preparation of cost estimates in sufficient detail to permit the selection for construction of any portion of the recommended program. Recommendations as to when each stage of the program should be constructed. Determination of the size of each stage of construction with consideration given to the financing capabilities of the City, taking into account to the maximum advantage all possible State and Federal grants.

12. Study of all of the City of Boston's connections to the Metropolitan Sewage System and determination of the quantity of flow of these connections assuming a velocity of 2 fps in the full pipe. Estimation of the average flow in these connections.

During the preparation of the report, conferences were held with City, Metropolitan District Commission, State, and other public agency officials whenever advantageous to keep them informed of the progress of the study and to coordinate the study in all of its phases with other studies and planning programs of the Boston Redevelopment Authority. Conferences were held with the Boston Redevelopment Authority to obtain information relative to future land development and use.

In conjunction with the preparation of the report, a set of maps, entitled "Plan of Existing Sewerage System", was prepared at a scale of 1-in = 400 ft in a form suitable for large-scale reproduction in quantity for the use of the Sewer Division of the Department of Public Works. Reduced size copies of these maps are presented in Appendix B of this report.

This investigation and report was conducted under the general supervision of Mr. Roland S. Burlingame and Mr. Charles A. Parthum. The Project Engineer was Mr. David R. Horsefield.

II INTRODUCTION

General Description of the City

The City of Boston is the capitol city of the Commonwealth of Massachusetts and is located on Massachusetts Bay. It serves as the principal financial, commercial and shipping center of the New England States. It is considered by many to be the cultural capitol of the United States because of the many contributions its citizens have made to the cause of liberty, justice, education and literary tradition.

The City form of government is administrated by an elected mayor and city council, acting through several departments. The Public Works Department is headed by a commissioner appointed by the Mayor, and a deputy commissioner.

Boston, like many other cities in the United States, has been suffering from the problems associated with urban decay. Among the symptoms of this decay have been continuing loss of population, high proportion of substandard buildings, loss of traditional industries, decline of the Port of Boston as a shipping center, and the lack of significant new construction.

In 1960 Boston began a major effort to counter urban decay. The Boston Redevelopment Authority (B.R.A.) was created for this purpose and a development administrator appointed by the Mayor. The B.R.A. put much of the city under General Neighborhood Renewal Planning (GNRP) to determine the needs of various areas.

At the present time, demolition and renewal construction in several areas of the city is well underway with major buildings completed, and plans are in preparation for other areas. In addition, these publicly financed renewal projects have stimulated much private construction and rehabilitation activity within the city.

History of the Boston Sewerage System Since 1950

The history of the Boston Sewerage system from early days through 1950 is presented in Appendix A.

In 1950 and 1951, engineering studies and investigations were carried out by Charles A. Maguire and Associates for the Metropolitan District Commission (MDC). Two engineering reports were submitted; "on the Comprehensive Sewage Plan of Sewage Disposal Needs and Alternate Plans, April 1950" and "on A Proposed Plan of Sewerage and Sewage Disposal for the Boston Metropolitan Area, February 1951." The 1951 report recommended the formation of a single sewerage district and that "joint disposal" of all of the sewage from the Boston Main Drainage System, from the Charles River Valley sewerage system of the South Metropolitan District, north and south of the river, and from the North Metropolitan District be adopted. Sewage from each of these systems would be conveyed by means of deep rock "tunnels under Boston and Boston Harbor to Deer Island, where....it would be treated at a single efficient plant, almost entirely self-powered by the use of sewage sludge gas, and discharged into the sea."

Chapter 645, Acts of 1951, authorized the construction of the Joint Plan recommended in the engineering report above with additional expenditures not to exceed $25,000,000. Specifically, this Act directed that the following projects be carried out:

Project A. The construction of a tunnel between Columbia Circle and Deer Island with necessary shafts and appurtenant works.

Project B. The construction of a tunnel between Ward Street pumping station and Columbia Circle with necessary shafts and appurtenant works.

Project C. The enlargement of the previously authorized Deer Island sewage treatment plant to care for the flow from Project A.

Project D. The construction of a relief sewer between Boston University Bridge and Ward street.

Project E. The construction of a relief sewer for the west side and Stony Brook interceptors of the Boston Main Drainage District.

Project F. The construction of a Marginal Conduit pumping station and appurtenant works.

Project G. The rehabilitation of tide gates and pumping stations.

This Act repealed Chapter 598, Acts of 1949, which had authorized and directed the construction of a separate treatment plant and appurtenant works for the Boston Main Drainage System at Calf Pasture. In addition, this Act made the Boston Main Drainage District a part of the South Metropolitan Sewerage System and directed the MDC to provide for the disposal by the South Metropolitan Sewerage System of the sewage from the Boston Main Drainage System. Under this Act, the City of Boston was authorized to grant to the Commonwealth of Massachusetts and the MDC was authorized to accept and maintain as part of the South Metropolitan Sewerage System any portions of the Boston Main Drainage System as the MDC and the Commissioner of Public Works mutually agree upon. The construction of Projects A, B, C, D and E, authorized under this Act, was begun shortly thereafter, and at present is nearly completed.

By means of Chapter 612, Acts of 1959, the North and South Metropolitan Sewerage Districts became the present Metropolitan Sewerage District, including the area served by the Boston Main Drainage System. In May 1967 the first diversion of flows from the Boston Main Drainage System to the Metropolitan system was effected at Camden Street. These flows enter the MDC Boston Main Drainage Tunnel through the Ward Street Headworks.

At the present time, an additional authorization of funds has been requested by the MDC for the construction of the proposed Charles River Dam and Pumping Station at Warren Avenue, the design of which has been completed. In addition, the MDC has requested funds for the rehabilitation of tide gates and the existing East Boston and Charlestown pumping stations.

Since 1900, no significant additions have been made to the existing principal interceptors, mains and submain sewers within the Boston Main Drainage Area. However, several structure failures have occurred in these sewers during this period, necessitating rehabilitation of several sections. In addition, redevelopment projects and expressway construction in the city have resulted in the reconstruction of short portions of the original lines.

In 1964, a report entitled "Preliminary Studies of Existing Utility Systems" was submitted by Charles A. Maguire & Associates, to the Boston Redevelopment Authority. This report describes certain portions of the existing Boston sewerage system in detail as they relate to urban renewal project areas and includes the results of sewer inspection and gagings conducted in the South End project area.

New street sewers have been constructed recently to serve redeveloping areas of the City, areas previously unsewered, and areas in which the City policy of separating sanitary sewage and storm drainage systems has been implemented. Separation of sanitary sewers and storm drains in areas served by combined sewers has been the policy of the City for many years and is discussed in Chapter VII and in Appendix F.

Datum Planes and Tide Levels

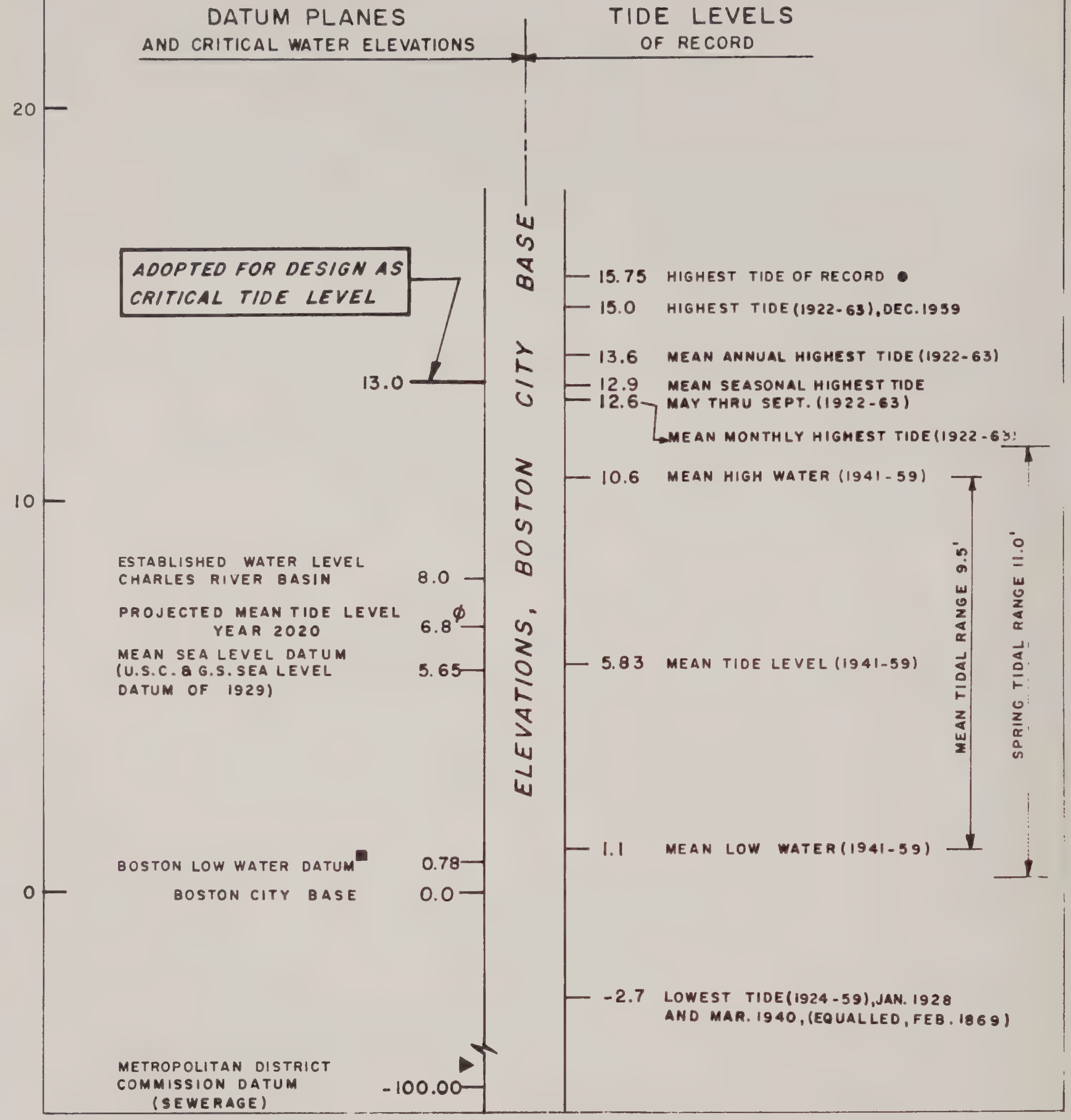
General

Four principal datum planes are relevant to this study. These are (1) Boston City Base, (2) Boston Low Water Datum from which soundings and tide levels are measured, (3) Mean Sea Level Datum (Sea Level Datum of 1929), as established by the U.S. Coast and Geodetic Survey (U.S. C. and G.S.) and (4) the Metropolitan District Commission Sewerage Datum. These datum planes are indicated at the left of Fig. 1, and all elevations shown throughout this report have been adjusted to the Boston City Base datum.

On the right of Fig. 1 are shown tide levels recorded from series of observations or from isolated tidal events. The highest tide of record is at Elevation (El.) 15.75, which is the so-called "Minot's Ledge Tide" observed on April 16, 1851. Mean Tide Level is indicated at El. 5.83, based on a series of observations by the U.S. C. and G.S. from 1941 to 1959. This elevation is slightly higher than Mean Sea Level Datum (El. 5.65) which is based on an earlier series of observations. The Mean Sea Level Datum has been adjusted to fit the North American network of precise levels.

Elevation 12.9 is the Mean Seasonal Highest Tide level observed at Boston from the first of May through the first of October for the 42-year period 1922 through 1963, based on the records of the U.S. C. and G.S. The period of May through September is the season in which harbor waters are most frequently used for recreation and during which pollution of harbor waters is most critical.

Elevation 13.6 is the level of the Mean Annual Highest Tide for all years from 1922 through 1963. The maximum tide elevation of record during the same period was El. 15.0 on December 29, 1959. During the storm of May 25 and 26, 1967, the tide reached an elevation of El. 14.8.


DATUM PLANES
AND CRITICAL WATER ELEVATIONS
TIDE LEVELS
OF RECORD
20
10
0
ELEVATIONS, BOSTON CITY BASE
ADOPTED FOR DESIGN AS CRITICAL TIDE LEVEL
13.0
ESTABLISHED WATER LEVEL CHARLES RIVER BASIN 8.0
PROJECTED MEAN TIDE LEVEL YEAR 2020 6.8 ϕ
MEAN SEA LEVEL DATUM (U.S.C. & G.S. SEA LEVEL DATUM OF 1929) 5.65
BOSTON LOW WATER DATUM ■ 0.78
BOSTON CITY BASE 0.0
METROPOLITAN DISTRICT COMMISSION DATUM (SEWERAGE) ▶ -100.00
15.75 HIGHEST TIDE OF RECORD ●
15.0 HIGHEST TIDE (1922-63), DEC. 1959
13.6 MEAN ANNUAL HIGHEST TIDE (1922-63)
12.9 MEAN SEASONAL HIGHEST TIDE
12.6 MAY THRU SEPT. (1922-63)
MEAN MONTHLY HIGHEST TIDE (1922-63)
10.6 MEAN HIGH WATER (1941-59)
5.83 MEAN TIDE LEVEL (1941-59)
1.1 MEAN LOW WATER (1941-59)
-2.7 LOWEST TIDE (1924-59), JAN. 1928 AND MAR. 1940, (EQUALLED, FEB. 1869)
MEAN TIDAL RANGE 9.5'
SPRING TIDAL RANGE 11.0'

● APRIL 16, 1851 "MINOT'S LEDGE TIDE"

■ DATUM OF HYDROGRAPHIC SURVEYS, BOSTON HARBOR, U.S. COAST & GEODETIC SURVEY

ϕ PROJECTED BY CAMP, DRESSER & McKEE

▶ EL. -99.97 IN SOME INSTANCES

NOTE:

DATA FROM U.S.C. & G.S. UNLESS NOTED OTHERWISE

CITY OF BOSTON, MASSACHUSETTS
REPORT ON IMPROVEMENTS TO THE BOSTON MAIN DRAINAGE SYSTEM

RELATION OF DATUM PLANES & TIDE LEVELS
BOSTON HARBOR

Camp, Dresser & McKee
Consulting Engineers
Boston, Mass.

SCALE AS INDICATED

SEPTEMBER, 1967

FIG. I

The projected mean tide level for the year 2020, at the end of the period of design for the proposed sewerage works, is El. 6.8, or about one foot above the 1941-1959 Mean Tide Level discussed above. This projected elevation is based on an estimated average rate of sea level rise with respect to Boston City Base of 0.014 ft per year from about 1950, the mid-point of the 1941-1959 period, to the year 2020. The estimated rate of rise is equal to the average rate determined from records of the U.S. C. and G.S.

Critical Tide Level

Based upon consideration of recorded tide levels, we have adopted El. 13.0 (Boston City Base) as the Critical Tide Level to be used in determining overflow elevations, the capacities of sewers, and pumping heads affected by tidal action. This elevation, indicated on Fig. 1, is slightly higher than El. 12.6, which is the Mean Monthly Highest Tide for the period of record 1922 to 1963, and includes some allowance for the anticipated rise in sea level. It should be noted that El. 12.5 is the maximum level to which the Charles River Basin rose in September 1955, during Hurricane Diane.

In 1941, a technical report prepared for the MDC showed the per cent of total time that the tide level in Boston Harbor was at or above a given elevation during the period 1922 through 1939. It was shown that the tide level stood above El. 13.0 for about 0.05% of the time in that period of years or for about one hour in every 2000 hours. For the conditions projected to the year 2020, we estimate that the tide would stand at or higher than El. 13.0 for about 0.8% of the time, or about one hour in 125 hours.

Curves of the highest tides for Boston Harbor, recorded monthly and annually for the period from 1922 to 1963 inclusive, are shown on Fig. 2 In addition, curves of monthly and annual highest tides projected to the year 2020 are shown. These projected tide curves have been drawn in positions 1.1 ft higher than those for the period from 1922 to 1963 to reflect adjustment of tide levels for the projected rise in sea level relative to Boston City Base at the rate of 0.014 ft per year for the years between the mid-point of the period (about 1942) to about the year 2020. From Fig. 2, it appears that the Critical Tide Level adopted for design will probably be equalled or exceeded, for 1922 to 1963 levels, for an average of 27 per cent of all months and 86 per cent of all years. For levels projected to year 2020, the Critical Tide Level will probably be equalled or exceeded for an average of 97 per cent of all months and almost every year.

The probability of the simultaneous occurrence of a high tide equal to or exceeding El. 13.0 and design storm rainfall intensity of 15 year frequency is slight. The peak runoff from such storms may be expected to occur less frequently than once in 15 years because of differing antecedent conditions. We have made no attempt to estimate the frequency of simultaneous occurrence of these events, but such occurrence will probably take place much less frequently than once in 15 years.

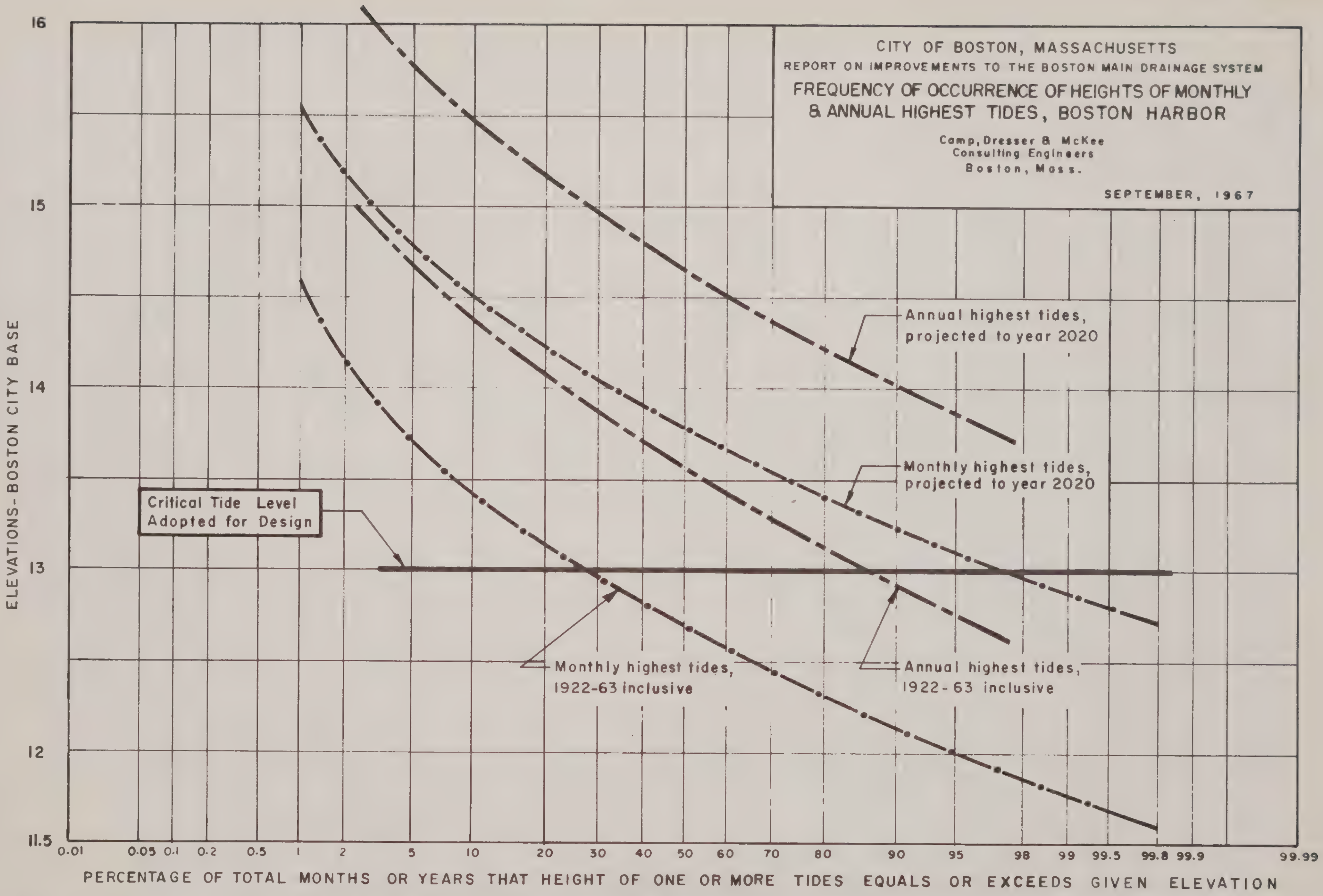


FIG. 2 FREQUENCY OF OCCURRENCE OF HEIGHTS OF MONTHLY & ANNUAL HIGHEST TIDES, BOSTON HARBOR

257-8331

Topography and Climate

The location of the major portions of the city is in the lowland of the Boston Basin, facing Boston Harbor, an arm of Massachusetts Bay, and divided by the Charles and Mystic Rivers. Boston was originally a peninsula with great areas of salt marshes on both the north and south sides. Much of this marshland area is now filled with its surface only slightly above high water level. Large areas of made land occur in the Back Bay, West End and South End areas of downtown Boston, in South Boston, Dorchester, Charlestown and East Boston. In such areas, it has been difficult to provide satisfactory sewerage. The effect of progressive filling of the lowlands has been the extension from time to time of pipes at flat gradients to the new shore lines as described in Appendix A.

In the southwestern part of the city and in Charlestown, South Boston, East Boston, and Beacon Hill in downtown Boston, the ground is relatively high, with steep surface slopes favoring the economical provision of adequate sewerage and drainage. The highest elevations in Boston are slightly over 300 feet above sea level.

The climate of Boston is that of the temperate zone, moderated by its proximity to the ocean. The city lies in the belt of prevailing westerlies and in the path of three major storm tracks. This results in rapidly varying weather patterns. Major storms are frequently accompanied by northeast winds. Hurricanes have approached Boston many times and occasionally have passed through the city.

The annual average temperature is 51°F, and has varied between extreme recordings of 104°F and -18°F. The average rainfall is about 43-in, generally well distributed throughout the year. Extreme monthly amounts of rainfall range from 17.09-in to 0.35-in, and the maximum 24-hr depth is 8.40-in which occurred in 1955 during Hurricane Diane.

Flooding Problems

Of the almost 3,400 reports of complaints received in 1965 by the Sewer Division of the Boston Public Works Department from property owners or department field staff members, we have examined and classified about 2,000. Almost one-quarter of these were found to be related to sewer stoppages, sewage overflows (at other than overflow structures), flow at excessive water surface level (surcharges) or sluggish flow indicating obstructions or insufficient capacity downstream. Defective catch basins, manholes, and deficiencies of drains or plumbing on private property were not included in this count.

Reported stoppages in 1965 were clustered in areas in the North End centered on Salem Street at Prince Street, in the Back Bay northwest of Tremont Street and east of Massachusetts Avenue, in the South End near Shawmut Avenue and Waltham Street, and in East Boston centered at Maverick Street at Cottage Street. Individual and small groups of reported locations were scattered throughout the city. Surcharged sewers and sluggish flows were reported in the same four principal areas.

Reported flooding, in the case of combined systems, usually implies the presence of mixed sanitary sewage and storm water in the basement of a residence or a commercial building causing nuisance conditions. This may result in a hazard to health, as well as property damage by inundation. At the least, the threat of basement flooding results in the loss of uninhibited use of the area for normal living purposes.

Flooding on the other hand, may also take the form of ponding in gutters or at street intersections which may act as temporary barriers causing annoyance to pedestrians.

Flooding of street surfaces to depths which obstruct vehicular traffic occur with moderate and heavy rainfalls at several low areas. Such areas include the underpass at Southampton Street at the New Haven Railroad (below Elev. 15.), at the intersection of Ruggles Street and Parker Street (Elev. 18), in South Boston on East Third Street between K and L Streets (Elev. 28), on Charles Street between Beacon and Boylston Streets near the Boston Common Garage entrances protected by low drains (below Elev. 15), in Roxbury on Massachusetts Avenue at the New Haven Railroad underpass near New Market Square (below Elev. 15). The vehicular tunnel of the Central Artery beneath Dewey Square, areas in and near Kenmore Square, and portions of Storrow Drive also have been flooded seriously enough to delay traffic.

Works to control the water surface elevation of the Charles River Basin are reportedly under consideration by the MDC, in the form of a proposed dam and pumping station in the vicinity of the Warren Avenue Bridge to replace the dam at the former Craigie Bridge, built in 1910. The proposed pumping station would have capacity to discharge storm flow from the basin to the hHarbor at all stages of the tide. Present discharge by gravity is effective only when tide level is below the level in the basin.

Much of the South End district, an area of about 190 acres, being almost all filled land, is too low to provide adequate drainage to the Fort Point Channel and the recently construction drain through the former South Bay. The original point of disposal for surface drainage to the former Receiving Basin at El. +3.0 in a portion of the estuary of the Charles River was lost when the Receiving Basin was filled in about 1860. Drains built when the South End district was developed were of relatively large size to provide storage for storm water between the periods when the tide level in the former South Bay was below the drain outlet levels. To assist surface drainage, about 50 acres of the district, including streets and buildings, were raised in about 1870. The Union Park Street Pumping Station was constructed in 1913-15 to serve about 82 acres of this district. Other portions of the district, including an area at East Concord Street were not included. The pumping station is reported to be in poor condition and necessary measures for its rehabilitation are in progress.

Subsurface Conditions

Subsurface conditions in the Boston area, affecting the construction of tunnels and open cut conduits, range from sound bedrock and firm glacial till to soft mud and made land in filled areas. Information on these conditions is derived from studies made over many years of the general geologic features, from hundreds of borings, and from examination of exposed cuts and rock faces in surface excavations and tunnels. Important sources are the Engineering Geology Branch of the U.S. Geological Survey and the publications of the Boston Society of Civil Engineers.

A great deal of subsurface data along the routes of conduits proposed in the Initial Construction Program, as well as throughout the city, is available as a result of many borings and excavations taken in connection with numerous construction projects. Information for a number of representative borings located along these routes is presented in Appendix G. To supplement this information, we have taken 37 borings for which results are presented in Appendix G.

On Fig. 3 are indicated the principal bedrock tunnels and geologic features of the Boston Basin, which extends between the Northern and Southern Boundary Faults. The dominant features are the Central Anticline, the axis of which plunges in an easterly direction beneath Dorchester Bay, and the Charles River Syncline to the north. These represent an up fold and adjacent down fold of the deep layers of sedimentary rocks overlying the igneous basement rocks.

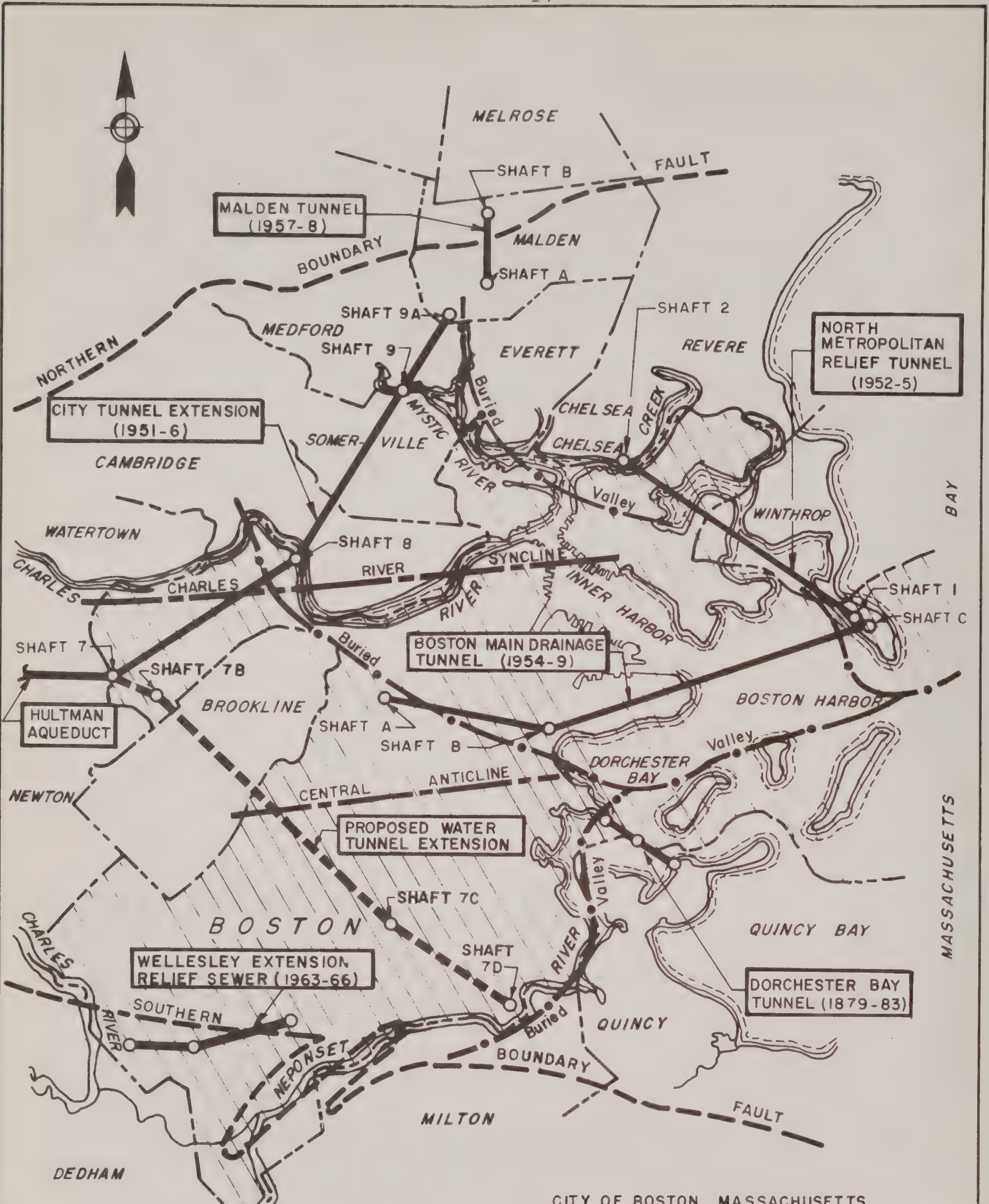
The sedimentary rocks are mainly argillite ranging in hardness from siltstone to slate, and conglomerate. Both are interrupted by horizontal and steeply sloping layers of harder intrusive igneous rocks, chiefly diabase, in the form of sills and dikes. Some layers of sandstone and shale are present.

The argillite is a generally gray fine-grained, hard, brittle rock with regular bedding. Other colors, such as purple, brown, and green are found. Some seams of the argillite have been altered to a soft material. Conglomerate, sometimes called "pudding stone", and a similar rock, tillite, are collections of well defined individual pebbles and cobbles, cemented into hard masses by a matrix composed principally of quartz and feldspar.

The approximate locations of buried valleys carved into the sedimentary layers are also shown on Fig. 3. In Roxbury and North Dorchester, the so-called Charles Buried Valley extends generally from northwest to southeast to Dorchester Bay, thence easterly to south of Deer Island. The existing MDC Main Drainage Tunnel lies roughly 1-1/4 mi. north of the center of the valley from Columbus Park (Shaft B) to Deer Island (Shaft C). The floor of this rock valley is generally 200 to 240 ft below mean low water from Ward Street (Shaft A) to Deer Island.

The overburden of unconsolidated sediments, in order upwards from the surface of the bedrock, comprises generally layers of weathered rock, glacial till, marine clay and silt (Boston Blue Clay), glacial outwash of cobbles and gravel, and sorted sands and gravels. At the top are deposits of silt, clay and peat, and in many areas, man-made fills of debris or sand and gravel. Any of these layers, of course, may not be present in a given location.

Ground water levels in the lowland areas generally are affected by tidal action and lie only slightly above mean sea level, except where they may have been lowered locally by excessive infiltration into sewers or by pumping to dewater excavations. In the upland areas, not affected by tide water, the ground water level is generally well below the surface on slopes and summits of hills, and near the surface at watercourses in the valleys.



CITY OF BOSTON, MASSACHUSETTS
REPORT ON IMPROVEMENTS TO THE BOSTON MAIN DRAINAGE SYSTEM

PRINCIPAL BEDROCK TUNNELS
& GEOLOGIC FEATURES OF BOSTON BASIN

Camp, Dresser & McKee
Consulting Engineers
Boston, Mass.

Note:
Geologic structural features are generalized.

1 0 1 2
SCALE IN MILES

SEPTEMBER, 1967

FIG. 3

In the Back Bay and South End sections of the city, most cellar grades are higher than Elev. 12.0. The water surface of the Charles River Basin is controlled at about Elev. 8.0. Ground water in these areas is reported as fluctuating between Elev. 5.0 and Elev. 8.0. A minimum ground water level of Elev. 5.0 is required in some areas to protect underground wood structures.

III EXISTING BOSTON SEWERAGE AND DRAINAGE SYSTEMS

General Description

The systems of sewers and drains in Boston as in other large, older cities, grew without being planned with objectives now prevailing, and a brief history is contained in Appendix A. Many of the older areas are served by a single system of common sewers into which both sanitary sewage and storm water is discharged (combined system). Most of these older areas are served by the Boston Main Drainage System. Many more recently developed areas are served by separate sanitary sewerage and storm drainage systems which in many cases discharge into combined systems.

The MDC now receives sanitary sewage flows from part of Boston into its South Metropolitan Sewerage System for disposal at Nut Island. The MDC is currently putting into operation a new system of trunk sewers and drainage tunnels which will collect and carry most of Boston's sewage, including that from the Boston Main Drainage System, to Deer Island where it will be given primary treatment and chlorination before discharge to the sea as discussed in Chapter IV.

The principal components of these systems are shown in general on Fig. A, "Map of Principal Existing Sewers and Conduits", which is appended to this volume, and in more detail on Fig. 4 "Plan of Existing Sewerage Systems", (a key map and 17 sheets) in Appendix B of Vol. 2.

Existing tide gates, regulators and outlets are discussed hereinafter. The condition and capacity of each combined sewer outlet are listed in Table 1, Appendix D of Vol. 2.

The Boston Main Drainage District, within which are located areas served by combined and partially separated sewers tributary to the Moon Island Detention Facilities, is shown on Fig. 5 by means of cross hatching. The remaining areas of Boston shown without cross hatching on Fig. 5 are served in most cases by separate sewers, through connections to the MDC Sewerage System. The total sewered area of Boston is about 20,500 acres and the portion served by the Boston Main Drainage System during dry weather is about 10,800 acres, including small areas in Milton and Quincy.

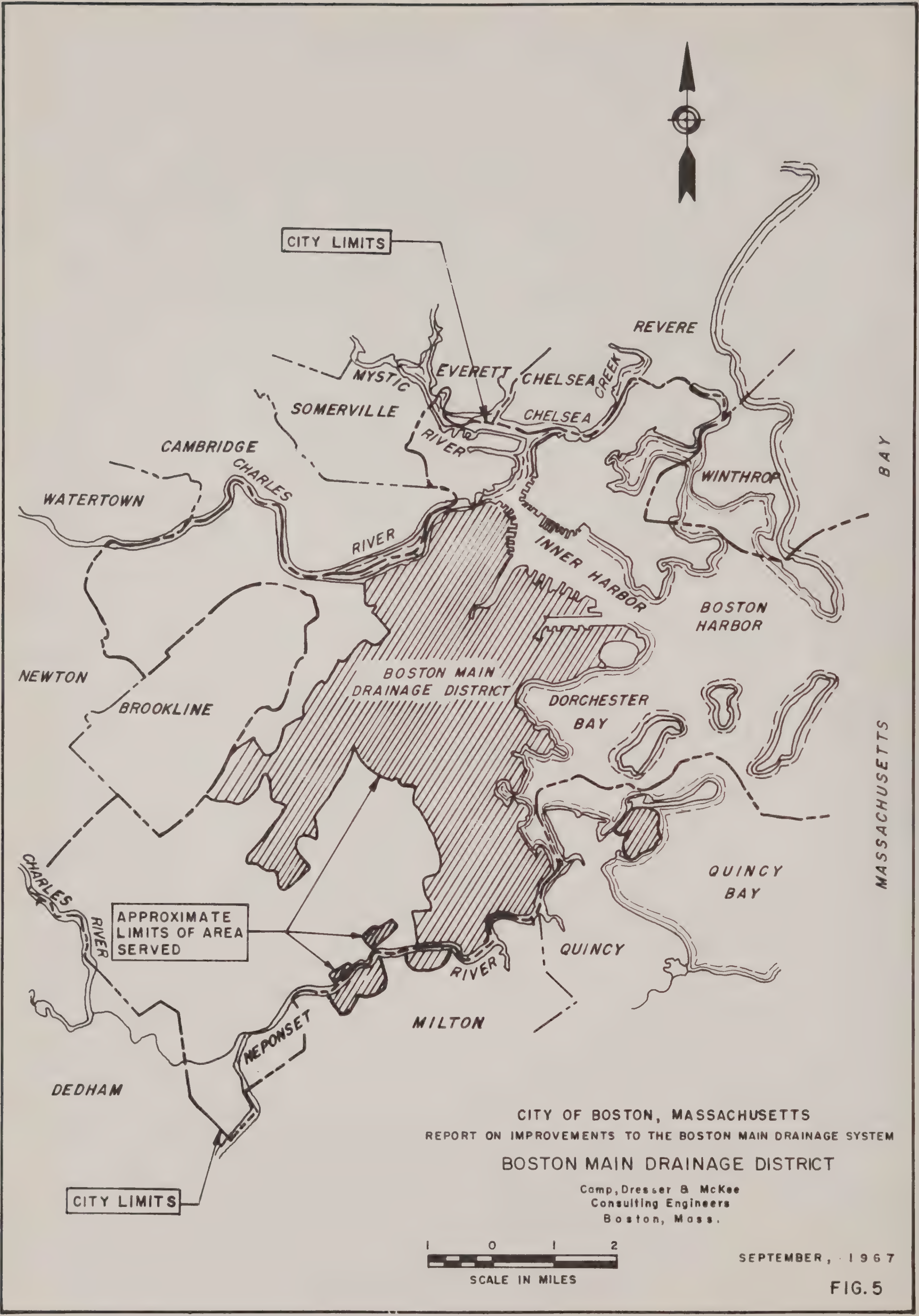
The total length of common sewers and surface drains in operation in the city at the end of 1965 was reported to be 1,360 miles, including 24.1 miles of intercepting sewers in the Main Drainage System and 6.8 miles of trunk sanitary sewers directly connected to the MDC Sewerage System. In 1962, a total of 723 miles of streets contained sewers.

Capacities shown are for conduits flowing full except as otherwise described. For conduits subject to tidal action effective capacities may at times approach zero with back up in the conduits.

Boston Main Drainage System

The principal components of the Boston Main Drainage System serving the Boston Main Drainage District are the Boston Main Interceptor, five branch interceptors, and outlet works. The five branch interceptors are the East Side Interceptor, West Side Interceptor, South Boston Interceptor, Dorchester Interceptor and Stony Brook Interceptor.

In addition to these principal components, two major district trunk sewers join the Boston Main Interceptor directly through dry weather connections.



CITY OF BOSTON, MASSACHUSETTS
REPORT ON IMPROVEMENTS TO THE BOSTON MAIN DRAINAGE SYSTEM

BOSTON MAIN DRAINAGE DISTRICT

Camp, Dresser & McKee
Consulting Engineers
Boston, Mass.

SEPTEMBER, 1967

FIG. 5

The two sewers are known as the Dorchester Brook Sewer and the Roxbury Canal Sewer. Outlet conduits from these two districts are known as the Dorchester Brook Conduit and the Roxbury Canal Conduit respectively.

All of the above components of the Boston Main Drainage System are described below. A description of the entire Stony Brook System is also included inasmuch as it serves a large portion of the Boston Main Drainage District.

Connections to the MDC sewerage system are described in Chapter X.

Photographic inspection to determine the structural conditions of conduits in the Boston Main Drainage System could not be accomplished due to high water levels. Gagings of water levels were made at several selected points in August 1966 before the MDC diversion at Camden Street took place, and it was found that there was not sufficient time during low tide periods nor was there sufficient clearance below the crowns of the conduits, to permit photography even with all available pumps at the Calf Pasture Pumping Station operating. After the MDC diversion took place in May 1967, gagings and observations were again made with results similar to those obtained earlier. We have, therefore, utilized photographic and other evidence previously obtained in evaluating the conditions of conduits. Extensive photographic inspection was accomplished in 1963 of portions of the Boston Main Interceptor and East Side Interceptor and a small portion of the Stony Brook Interceptor in conjunction with preliminary investigation of the sewerage system in the South End Urban Renewal Project area. Additional photography has been done by the city on portions of the Boston Main Interceptor and Dorchester Brook Sewer.

Recommended improvements to the Boston Main Drainage System are discussed in Chapters VIII and IX.

Boston Main Interceptor

The Boston Main Interceptor is the outfall sewer for the entire Boston Main Drainage System. This interceptor serves an area of about 10,220 acres tributary to the MDC Columbus Park Connection which is now under construction.

Downstream from the connection it lies in Mt. Vernon Street terminating at the Calf Pasture Pumping Station. The interceptor extends westerly in Mt. Vernon Street from the MDC Columbus Park Connection to Boston Street, and in Boston Street, Willow Court, right-of-way and Clapp Street to Massachusetts Avenue, thence northwesterly in Massachusetts Avenue to Washington Street, in Washington and Camden Streets to the Providence Division tracks of the New Haven Railroad, and in Gainsborough Street to Huntington Avenue. At Gainsborough Street at Huntington Avenue, it is joined by the West Side Interceptor and formerly was joined by the Charles River Valley Sewer, now reconnected to the MDC sewerage system at Ward Street. The total length is about 2-1/2 miles.

At Tremont Street the main interceptor is connected to the MDC Boston Main Drainage Relief Sewer, a relief conduit discharging to the Ward Street Headworks which was placed into operation in May 1967.

The main interceptor at the Columbus Park Connection is 126-in diameter circular brick conduit, and its estimated capacity flowing full is about 185 mgd. Upstream of Tremont Street it is a 90-in x 92-in modified circle brick conduit, and its estimated capacity flowing full is about 80 mgd.

The interceptor passes through the Dorchester Improvement Area, borders the Roxbury-North Dorchester General Neighborhood Renewal Plan (GNRP), extends across the South End Urban Renewal Area, and into the Parker Hill-Fenway GNRP.

The estimated capacities of the interceptor flowing full are inadequate for the estimated year 2020 peak dry-weather flows, but if all flows from the West Side Interceptor and Stony Brook Interceptor are diverted to the MDC Ward Street Headworks as planned, the capacities would be adequate for the estimated peak dry weather flows from the areas then remaining tributary.

The poor structural condition of the sewer is evidenced by failure of the sewer in two places, in Mt. Vernon Street east of the Southeast Expressway in 1961 costing over $120,000 to repair, and in Massachusetts Avenue near Clapp Street in 1962 costing over $180,000 to repair. In addition, both repairs involved other large expenditures caused by the loss of use of the sewer, traffic rerouting and delays and damages from emergency overflows of sanitary sewage. Traffic is now barred from passing over the interceptor in the portion of Massachusetts Avenue east of the New Haven Railroad bridge. The structural condition of other portions of the Boston Main Interceptor, particularly in Massachusetts Avenue is considered to be poor.

East Side Interceptor

The East Side Interceptor and its associated principal sewers and conduits serve the South End, downtown Boston and North End sections of the city, a total tributary area of about 1,030 acres. Most of the sewers in this district are on the combined plan. Some streets, however, contain two or more structures carrying sanitary sewage and/or storm water. Most conduits connect to combined sewers, with a few storm drains discharging directly to the Inner Harbor.

The principal subdistricts in order upstream from Massachusetts Avenue where the interceptor connects to the Boston Main Interceptor are those connected at East Concord Street, East Dedham Street, Union Park Street, East Berkeley (Dover) Street, a point south of Broadway (formerly Troy Street), Kneeland Street, Oliver Street-Purchase Street (which includes much of the downtown shopping district), Central Street including the Canal Street Relief Sewer district, Clinton Street, and the area north of Richmond Street along Commercial Street to north of Hanover Street.

The interceptor extends northeasterly in Albany Street from Massachusetts Avenue to near Herald (Castle) Street, thence easterly and northerly in the New Haven Railroad yards to Atlantic Avenue near Beach Street and in Atlantic Avenue and Commercial Street to Hanover Street, a total length of about 2.9 miles. Sections have been replaced in the railroad yards and along the Central Artery (Fitzgerald Expressway), and relocations will be required by work in the Downtown Waterfront Urban Renewal project areas.

Boston Public Library

The interceptor is a 66-in x 68-in modified-circular brick conduit at its junction with the Boston Main Interceptor at Albany Street, with an estimated capacity flowing full of 33.4 mgd. In Commercial Street, south of Battery Street, the conduit is 28-in x 42-in egg-shaped brick, with an estimated capacity flowing full of about 7.5 mgd. Downstream of Clinton Street the estimated capacities of the interceptor are inadequate for estimated year 2020 peak dry weather flows.

Wet weather flows of mixed sewage and storm water in excess of pipe capacity overflow directly to the Roxbury Canal Conduit, Fort Point Channel and the Inner Harbor.

The physical condition of long sections of the sewer is poor as revealed by a photographic inspection of portions downstream of Dover Street in 1963. Substantial deposits of material have been found by soundings at manholes.

The subdistrict between Camden and Berkeley Streets, on the west and east, and between the Providence Division of the New Haven Railroad and Tremont Street on north and south, and along Union Park Street to Albany Street is an area of about 82 acres of fairly low flat land served by drainage pumps at the Union Park Street Pumping Station. The need for such a drainage pumping station became apparent with the filling of the former "Receiving Basin" in which water was to be held permanently, in the early 1800's, at Elev. 3.0 as part of a tidal power development. With the loss of the advantage of the low water level of the basin, and subsequent filling of the Back Bay in the period starting about 1858, drainage conduits in the Union Park Street and adjacent areas were constructed to discharge to the former South Bay east of Albany Street. The sewers in the streets leading to the South Bay were made extra large to provide storage capacity for sanitary sewage and storm runoff between the periods when the tide level would be low enough in South Bay to allow the conduits to drain. When the East Side Interceptor was constructed in 1879, open connections at East Dedham Street and at Dover Street were provided for unobstructed access to the intercepting sewer without the control of regulating devices. Even with the diversion to Fort Point Channel, however, of all sewage from the East Side Interceptor north of Dover Street through an overflow controlled by a district regulator at Dover Street, the capacity of the interceptor was not sufficient to provide relief for the low areas between Massachusetts Avenue and Camden Street. As a result of need indicated by frequent flooding, the Union Park Street Pumping Station was constructed and put into operation in 1915, to pump mixed sewage and storm water from the low level storm drainage system serving the Union Park Street district to the Roxbury Canal through a short force main. The station is now in process of rehabilitation, with the provision of new pumping equipment and piping.

The Downtown Waterfront-Faneuil Hall Urban Renewal Project Area (Project No. Mass. R-77) of the Boston Redevelopment Authority includes provisions to reconstruct Atlantic Avenue from near High Street north to near Richmond Street on an alignment about 300 feet west of its present route to lie just east of the Fitzgerald Expressway. This will require the reconstruction in the new Atlantic Avenue alignment of the East Side Interceptor between High Street and Richmond Street. The BRA is taking advantage of this opportunity for reconstruction to provide a conduit of adequate capacity for

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estimated future peak dry weather flows. Planning of the Central Business District Urban Renewal Project area also includes reconstruction of a portion of the East Side Interceptor with adequate capacity.

The removal and reconstruction of buildings in the Government Center Urban Renewal Project area, with accompanying relocation of streets, has provided the opportunity for separation of the existing combined system in this area. This has been done to the extent of providing separate sanitary sewers and storm drains in the several new streets. However, these receive flows from plumbing systems which have not been separated in several buildings which are not to be reconstructed, and all flows discharge to existing combined sewers downstream.

The Canal Street Relief Sewer was constructed essentially as an upstream extension of the East Side Interceptor from Central Street northeasterly to Canal Street at Causeway Street near the North Station. There is a junction structure at the upstream end of the relief sewer at the West Side Interceptor provided with stop logs which effectively prevent flow to or from the West Side Interceptor which is about three feet higher. The drainage area is located on the northeast slope of Beacon Hill, including the Government Center, and level land adjacent on the north and east. The capacity flowing full of this relief sewer downstream from Haymarket Square is inadequate to carry flows of mixed sewage and storm water resulting from the 15 year design storm from this entire area.

West Side Interceptor

The tributary area served by the West Side Interceptor is located generally on the northwest side of the Boston peninsula including the West End section and much of the filled area of the Back Bay. It extends generally from the Back Bay Fens on the west to Copps Hill on the east and from the Charles River Basin and estuary on the north to a line on the south and southeast at the Providence Division of New Haven Railroad, and the Massachusetts Turnpike east to Tremont Street, thence along Tremont Street to Boylston, along Boylston to Arlington, along Arlington to Beacon, Beacon to near Somerset Street, and along Somerset and New Sudbury Streets to near Haymarket Square, and along Merrimac Street to south of Causeway Street, thence east to Copps Hill. The area at the connection of the West Side Interceptor to the Boston Main Interceptor in Gainsborough Street is about 615 acres.

The West Side Interceptor is located in Gainsborough Street to Falmouth Street, in Falmouth to Dalton Street, thence northwesterly in Dalton and Hereford Streets to Beacon Street. From this point it extends northeasterly in Beacon Street to Charles Street, north in Charles Street to Leverett Circle and generally easterly in Lowell, Causeway and Commercial Streets to Charter Street.

The junction with the Boston Main Interceptor is at Huntington Avenue at the north chamber of the siphon beneath the MBTA subway tunnel. Also this point is the former connection of the Charles River Valley Sewer of the MDC. The downstream portion of the Charles River Valley Sewer below the connection to Ward Street at Vancouver Street was abandoned as part of the Charles River Valley Sewer many years ago. Flow in a length of this sewer in Huntington Avenue has been reversed to the west toward the MDC Ward Street Pumping Station by rebuilding the invert.

A short branch of the interceptor was built in Brimmer Street from Mt. Vernon Street to Beacon Street to intercept sewers in Pinckney, Mt. Vernon, and Beacon Streets.

Combined sewers join the interceptor through regulators at Hereford, Fairfield, Dartmouth, Berkeley, Brimmer, Cambridge, Fruit, east of Allen Street, west of Leverett Circle and from place to place upstream of Leverett Circle. A major connection to the Canal Street Relief Sewer at Canal Street is blocked as described under the East Side Interceptor.

The Church Street subdistrict generally south of the Public Garden is a low-lying area. It is provided with an open connection to the interceptor, without regulator, to provide the best drainage for the district.

The area tributary to the West Side Interceptor includes the West End Urban Renewal Project and portions of the Downtown North and Back Bay General Neighborhood Renewal Plan areas and the Prudential Center Development. It is bordered on the east but does not include any of the Central Business District Urban Renewal Project area. The upstream end of Church Street subdistrict includes small parts of the South Cove and South End Urban Renewal Project areas south of Stuart Street.

The interceptor is a 57-in by 66-in egg-shaped brick conduit at its junction with the Boston Main Interceptor at Huntington Avenue, with an estimated capacity flowing full of 33.0 mgd. At Endicott Street it is a 32-in by 54-in oval-shaped brick conduit with an estimated capacity flowing full of 10.5 mgd.

Overflows from the West Side Interceptor are discharged to the MDC Boston Marginal Conduit. Under certain tide conditions, the Boston Marginal Conduit in turn overflows to the Charles River Basin. At other times all flows from the marginal conduit discharge to the tidal estuary east of the Charles River Dam.

The West Side Interceptor will be crossed by the extension of the MBTA subway now under construction northerly from Haymarket Square to Charlestown.

The Christian Science Church Development in the vicinity of the intersection of Massachusetts Avenue and Huntington Avenue will affect the existing West Side Interceptor. It is planned as part of this development to replace the section of the interceptor from Dalton Street to near Massachusetts Avenue and place it in a pipe gallery in the proposed buildings. Combined sewers which cross the building sites to join the interceptor will be appropriately relocated and reconstructed.

South Boston Interceptor

The South Boston Interceptor at its connection to the Boston Main Interceptor at Mt. Vernon Street serves a total tributary area of about 1,620 acres in South Boston generally east of the line of Dorchester Brook and north of the main interceptor. The trunk section of the interceptor extends generally northerly from the Boston Main Interceptor west of the Old Colony Division of the New Haven Railroad, passing beneath the railroad and thence northerly to Devine Way. Here it is joined by its two branches, the North Branch and the South

Branch. The North Branch extends along Dorchester Avenue and Foundry Street, thence easterly in First Street in low ground along the north side of the South Boston peninsula to L Street. The South Branch extends easterly along the south side of the peninsula to City Point and thence north via Marine Park to Second Street.

The South Boston Interceptor has connections to major combined sewer outlets located at three former brook channels. These are at Kemp Street (Outlet No. 98) and Vale Street (Outlet No. 97), both of which have been extended from Old Colony Avenue to outlets into Old Harbor at Carson Beach, and the outlet from D and Damrell Streets to the Dorchester Brook Conduit through the former South Bay area. Other outlets from combined sewers in this interceptor district are extended to the shore at the L Street and City Point Beaches from the South Branch, and into the Reserved Channel from the North Branch.

The trunk section of the interceptor south of Locust Street is 78-in reinforced concrete pipe diameter of recent construction with an estimated capacity flowing full of about 65 mgd. At Devine Way the trunk section is a 72-in diameter brick conduit with an estimated flowing full capacity of about 47 mgd. Only the 78-in diameter portion of the trunk section has sufficient capacity for estimated year 2020 peak dry weather flows. The capacity of the 72-in diameter portion is sufficient for future flows, if flows are diverted into the proposed Main Interceptor at Dorchester Avenue near B Street.

At Devine Way the South Branch of the South Boston Interceptor is a 36-in by 54-in egg-shaped brick conduit with an estimated capacity flowing full of 16.8 mgd. The South Branch is a 15-in vitrified clay pipe with an estimated flowing full capacity of about 1.5 mgd at Marine Park. The South Branch has inadequate capacity for estimated year 2020 peak dry weather flows except for the reach between Mercer Street and H Street.

The North Branch of the South Boston Interceptor at Devine Way is a 57-in by 66-in egg-shaped brick conduit with an estimated capacity flowing full of 36.6 mgd. At K Street the North Branch is a 24-in by 36-in egg-shaped brick conduit with an estimated capacity flowing full of 5.7 mgd. Upstream from B Street and West Seventh Street the North Branch has inadequate capacity for estimated year 2020 peak dry weather flows. Downstream to Devine Way it is estimated to have adequate capacity.

The structural condition of the sewer section originally constructed mostly of brick masonry, is not known.

Dorchester Interceptor

The Dorchester Interceptor extends generally south from its junction with the Boston Main Interceptor at Mt. Vernon Street along the coast on the east side of the Dorchester district of Boston to the Neponset River and thence westerly to Granite Avenue. It is joined at its upper end by a section sometimes called the Lower Neponset Valley Sewer of the MDC Neponset River Valley Sewer which extends westerly along the north bank of the Neponset River to about 0.4 of a mile west of Blue Hill Avenue.

This is the portion of the Neponset River Valley Sewer which remained connected to the Boston Main Drainage System after the connection of the westerly section of that sewer to the South Metropolitan High Level Trunk Sewer in 1904. The easterly section of the Neponset River Valley Sewer serves areas on the separate plan in the Mattapan section of Boston and two areas in the Town of Milton.

The Dorchester Interceptor and the easterly section of the MDC Neponset River Valley Sewer together serve an aggregate area of about 3,030 acres not including areas in the Town of Milton. The interceptor near the junction with the Boston Main Interceptor is a 60-in diameter brick conduit with an estimated capacity flowing full of about 29 mgd. At Granite Avenue it is a 54-in diameter brick conduit with estimated capacity flowing full of about 19 mgd.

The capacity of the Dorchester Interceptor sewer is inadequate throughout its entire length for the estimated year 2020 peak dry weather flows. The structural condition of the brick conduit is not known.

Dorchester Brook Sewer and Conduit

The watershed of enclosed Dorchester Brook is located in the northern part of Dorchester and the eastern part of Roxbury. It extends generally from near Massachusetts Avenue on the northeast to Franklin Park and Geneva Avenue on the southwest, and from southeast of Columbia Road to northwest of Blue Hill Avenue.

Much of the southern portion of the area is sewered by separate sanitary sewerage and storm drainage. The northern portion is served principally by combined sewers. Because the storm flow from the drains in the southern portion discharges to the north to the area served by combined sewers, all flows from the area are combined by the time they reach the Dorchester Brook Sewer.

Dry weather flow now discharges from the Dorchester Brook Sewer through a regulator and dry weather connection at Massachusetts Avenue to the Boston Main Interceptor. The portion of dry weather flow in excess of the capacity of the dry weather connection, and mixed sewage and storm water in wet weather, pass through a tide gate chamber to the Dorchester Brook Conduit and enter the Roxbury Canal Conduit and Fort Point Channel (Outlet No. 219) as described in Table 1 in Appendix D.

The principal branches of the Dorchester Brook Sewer are the East Branch, West Branch and the trunk section. The East Branch serves an area of about 320 acres, extending from Quincy Street and Ceylon Street to its junction with the West Branch at Norfolk Avenue. The West Branch serves an area of about 470 acres, extending from Blue Hill Avenue and Otisfield Street to the junction with the East Branch.

The trunk sewer extends northerly from the junction of the two branches at Norfolk Avenue through the yard of the Boston Edison Company to the regulator at Massachusetts Avenue. The total tributary area at Massachusetts Avenue is about 810 acres.

Inasmuch as the Dorchester Brook Sewer, including the two branches, is required to serve as a principal storm conduit, as well as a sanitary sewer, its adequacy to meet hydraulic requirements for dry weather flow and runoff from a 15 year design storm has been determined. The sewer at Massachusetts Avenue is a 156-in by 108-in horseshoe-shaped brick conduit with an estimated capacity flowing full of about 566 mgd. At Norfolk Avenue the East Branch is a 118-in by 106-in horseshoe-shaped concrete conduit with an estimated capacity flowing full of about 186 mgd, and the West Branch is a 102-in by 96-in horseshoe-shaped brick conduit with an estimated capacity flowing full of about 275 mgd. At Ceylon Street the East Branch is a 60-in by 60-in horseshoe-shaped brick and stone conduit with an estimated capacity flowing full of about 44 mgd. At Blue Hill Avenue the West Branch is a 60-in by 60-in horshoe-shaped concrete conduit with an estimated capacity flowing full of about 87 mgd.

The estimated capacities of the branch and trunk sewers upstream from Massachusetts Avenue and of the conduit downstream from Massachusetts Avenue are inadequate to handle the required rates of storm runoff. They are adequate for estimated year 2020 peak dry weather flows.

In March and April, 1966, photographic inspection was made by the City of 484 feet of the trunk section extending southwest from Massachusetts Avenue. This inspection showed that this section was in poor condition with a large crown crack evident for much of its length. The condition of the remainder of the sewer is not known.

The Dorchester Brook Conduit extends for about 4,400 ft north of Massachusetts Avenue, parallel to the Midland Division of the New Haven Railroad, passing beneath Southampton Street and the Southeast Expressway, thence northwesterly crossing beneath the Midland Division and passing for about 1,900 ft to a junction with the Roxbury Canal Conduit. From this junction the Roxbury Canal Conduit extends about 900 ft to the Fort Point Channel outlet (Outlet No. 219) north of the Dover Street - West Fourth Street Bridge embankment.

The Dorchester Brook Conduit at Massachusetts Avenue is a 142-in by 104-in horseshoe-shaped concrete conduit with an estimated capacity flowing full of about 120 mgd. At its junction with the Roxbury Canal Conduit it is a double 204-in by 162-in reinforced concrete box culvert and has an estimated capacity flowing full of about 1,420 mgd if tidal effects are not considered. Its condition upstream of the railroad crossing is not known, and the downstream section is currently under construction.

Roxbury Canal Sewer

The Roxbury Canal Sewer, a principal tributary to the Boston Main Interceptor at Massachusetts Avenue and Albany Street, serves an area in the Roxbury district of Boston of about 250 acres. The sewer extends southwesterly in Albany and Dearborn Streets to Dudley Street. At this point, it divides into two branches, one extending west in Dudley Street to Warren Street, and the second east in Dudley Street and south in Blue Hill Avenue to near Stafford Street. A principal submain sewer extends from the main sewer in Albany Street south in Hampden Street to near Dudley Street.

The tributary area is generally served by combined sewers with a few separate sanitary sewers and storm drains near the south edge. Mixed sewage and storm water from this tributary area discharges through a regulator into the recently constructed Roxbury Canal Conduit and thence to Fort Point Channel. The drainage area generally south of Eustis Street is high, steeply sloping ground, and the portion generally north and northeast of Eustis Street is former marsh land and therefore generally flat. At Massachusetts Avenue, the sewer is a 54-in x 57-in modified-circular brick conduit with an estimated capacity flowing full of about 57 mgd. The estimated capacity is inadequate for storm flows for the 15-year frequency design storm, in the reaches of the sewer in Blue Hill Avenue, in Dudley Street, in Dearborn Street and in Albany Street to Massachusetts Avenue. The structural condition of this brick sewer is not known.

At Massachusetts Avenue, the Roxbury Canal Sewer joins a common sewer in Massachusetts Avenue which in turn joins the main interceptor through the above described regulator south of Albany Street.

Roxbury Canal Conduit

The Roxbury Canal Conduit, constructed by the State Department of Public Works in 1965 and 1966, extends generally northeasterly from Massachusetts Avenue to the south end of the existing culvert beneath the West Fourth Street Bridge viaduct through which it discharges to the Fort Point Channel. The major branch of this conduit is the Dorchester Brook Conduit, the lower reaches of which are now under construction.

The Roxbury Canal Conduit receives the discharges and overflows of mixed sewage and storm water from the Roxbury Canal Sewer at Massachusetts Avenue, from common sewers in Massachusetts Avenue north and south of the conduit, from outlets at East Concord Street, East Dedham Street, Union Park Street, and Dover Street and from the Dorchester Brook Conduit.

The drainage area tributary to the conduit is the area which drains naturally to what was formerly South Bay.

Stony Brook System

The Stony Brook system maintained by the city consists of five principal sewers and conduits. These are known as the West Roxbury Low Level Sewer, Stony Brook Valley Sewer, Stony Brook Interceptor, Old Stony Brook Conduit, and Stony Brook Conduit. These sewers and conduits together with their principal tributaries are described below.

The Stony Brook drainage area upstream of the Boston Gate Houses at the Fens has an area of about 9,300 acres. It includes portions of Hyde Park, West Roxbury, Dorchester, Roxbury and Back Bay, and an area in the southeast corner of the Town of Brookline. The drainage area extends from the Dedham town line on the South to the Charles River Basin on the North, and from Walnut Hill in Brookline on the west to Codman Square in Dorchester on the East. It is bordered on the West by the Muddy River watershed which is tributary to the Fens, and through the Muddy River Conduit, to the Charles River Basin.

The proposed Southwest Expressway, presently being designed, will traverse the drainage area from north to south along the route of the Providence Division of the New Haven Railroad, which is to be abandoned. The expressway is planned to provide four lanes in each direction and leave room for a three-track rapid transit line in the median. Extending across the north end of the drainage area is the section of the Inner Belt Highway being designed to extend from the Southeast Expressway to the Charles River west of Boston University Bridge.

Extensive urban renewal projects are being undertaken in the Washington Park area and in the South End area, both on the northeast boundary of the watershed. Much of the balance of the watershed north of Forest Hills lies in the Parker Hill-Fenway and the Jamaica Plain General Neighborhood Renewal Plan areas (GNRP). Large portions of the area south of Forest Hills lie in the West Roxbury, Roslindale and Hyde Park Improvement Areas.

The Stony Brook drainage area is generally served by a system of separate sanitary sewers and storm drains south of Rossmore Road and by a system of combined sewers north of Rossmore Road. However, extensive areas in the northern part of the drainage area have been converted to the separate plan and the conversion program has been accelerated in recent years, in conjunction with the urban renewal work.

An analysis of the existing principal conduits serving the Stony Brook drainage area indicates that these conduits may be inadequate to serve the intended purposed when the area is fully developed. These conduits are discussed in more detail below.

Two systems of sanitary sewers serve the portion of the Stony Brook drainage area to the south of Rossmore Road. The higher ground is served by the MDC South Metropolitan High Level Sewer described in Chapter IV. This sewer was put into operation in 1904 to relieve the Boston Main Drainage System which has been extended beyond the ultimate limits contemplated in the original design and which was becoming badly overloaded. Principal sewers tributary to the South Metropolitan High Level Sewer within the Stony Brook drainage area include the Talbot Avenue High Level Sewer from the Canterbury Brook area and the Roslindale Brook Sewer in Washington Street.

The lower ground to the south of Rossmore Road (near McBride Street) is served by the West Roxbury Low Level Sewer. This sanitary sewer extends northerly along Hyde Park Avenue from near Southbourne Road to near Walk Hill Street where the sewer is incorporated in the east haunch of the Stony Brook Conduit. Both conduits extend northerly and parallel to the railroad to Centre Street. The low level sewer continues northerly as a separate conduit in Columbus Avenue and then swings easterly in Tremont Street and Linden Park Street to discharge into the Stony Brook Interceptor, utilizing one of the barrels of the Old Stony Brook Conduit structure for some of the reaches along the way.

The West Roxbury Low Level Sewer was built in 1913 along with the Stony Brook Conduit to provide an outlet for sanitary sewage from the separated areas south of Rossmore Road not tributary to the MDC system. It varies in size and capacity flowing full from 30-in diameter and 4.1 mgd at Southbourne Road to a 24-in by 42-in egg-shaped, brick sewer and 6.0 mgd in the section located in the east haunch of the Stony Brook Conduit. Estimated capacity of the sewer is inadequate for estimated year 2020 peak dry weather flows. The condition of the sewer is not known.

The portion of the Stony Brook drainage area north of Rossmore Road is served by a system of combined sewers tributary to the Stony Brook Valley Sewer. This sewer also parallels the Providence Division tracks of the New York, New Haven and Hartford Railroad from south of Forest Hills Square northerly to near Roxbury Crossing where it turns northeasterly on Roxbury Street and Elmwood Street to near Linden Park Street. At this point it discharges dry weather flows into the Stony Brook Interceptor and wet weather flows into the Old Stony Brook Conduit.

The Stony Brook Valley Sewer was built in the latter half of the nineteenth century to carry combined sewage from the Stony Brook watershed to tide water. It was connected to the interceptor in 1881 and dry weather flows were diverted in 1884. The sewer varies in size and capacity flowing full from a 36-in x 48-in egg-shaped, brick sewer and 10 mgd at Forest Hills to a 60-in x 78-in egg-shaped, brick sewer and 68 mgd at Roxbury Street. It is adequate in capacity to carry year 2020 estimated peak dry weather flows and may be considered to act somewhat as an interceptor, discharging wet weather flows to the Stony Brook Conduit. Its condition is not known.

The Stony Brook Interceptor extends from the outlet of the Stony Brook Valley Sewer in Elmwood Street near Linden Park Street, in Hampshire Street, Cabot Street, and Tremont Street to Camden Street. A branch interceptor extends southwest in Cabot Street to pick up the dry weather flow from the Maywoods Brook conduit in Vernon Street. Other branch interceptors extend on Ruggles Street northwesterly to Forsyth Street and southeasterly to Shawmut Avenue to pick up dry weather flows from local combined sewers.

The Stony Brook Interceptor, together with its branches was constructed as a part of the Boston Main Drainage System in 1878 - 1881 and put into service in 1884. The West Roxbury Low Level Sewer was connected to it in 1913. The interceptor varies in size and capacity flowing full from a 48-in x 54-in ovoid-shaped, brick conduit and 31 mgd at Linden Park Street to a 54-in x 56-in modified circle-shaped, brick conduit and 39 mgd at Camden Street. It is inadequate to carry estimated year 2020 peak dry weather flows from the Stony Brook drainage area. Recent reports indicate that portions are in good condition.

The Old Stony Brook Conduit receives the wet weather flows from the combined sewers tributary to the Stony Brook Interceptor. It is not to be confused with the newer Stony Brook Conduit (described below) which extends upstream from the Commissioners Channels in Parker Street and which now serves as the main drain for the Stony Brook watershed. The old conduit also receives wet weather flows from combined sewers at Roxbury Crossing and at Huntington Avenue. The conduit extends from Roxbury Crossing in Tremont Street, Linden Park Street, easement; Downing Street, Forsyth Street, and easement to Boston Gate House No. 2. Low wet weather flows discharge through an 84-in diameter circular conduit, the easterly of the two Foul-Flow Channels, extending along the east bank of the Back Bay Fens to the MDC Fens Gate House on the bank of the Charles River. At lower tide elevations in Boston Harbor, the flows are discharged through the Boston Marginal Conduit to downstream of the Charles River Dam. At higher tide elevations, the flows are discharged directly to the Charles River Basin through the MDC Fens Gate House outlet and several other outlets along the conduit. At times of excessive wet weather flows, discharges are made in addition directly to the Back Bay Fens through the outlet at Boston Gate House No. 2.

The Old Stony Brook Conduit was reconstructed in 1909, replacing the downstream portion of the original double-open channels which had been extended as walled-channels and then covered over as far upstream as Green Street, in the latter half of the nineteenth century. The present conduit varies in size and capacity flowing full from a 96-in x 72-in horseshoe-shaped concrete conduit and 88.5 mgd at Linden Park Street to a double 99-in x 126-in rectangular reinforced-concrete conduit and 382 mgd at Huntington Avenue and to a double 120-in x 120-in rectangular reinforced concrete conduit and 655 mgd at Gate House No. 2, with a design water surface in the Fens of Elev. 13.0 (Boston City Base). Only portions of this conduit upstream from Downing Street and downstream from Hemenway Street have adequate capacity for the estimated 15 year design storm flow.

The new Stony Brook Conduit was designed to relieve the old channels. The lower portion known as "the Commissioners Channel" was built as a result of the serious flooding which occurred in February, 1886. The Stony Brook Conduit subsequently was extended south along the brook to near the Stony Brook Reservation. The conduit parallels the Providence Division tracks of the New Haven Railroad from near the Stony Brook Reservation to Roxbury Crossing thence westerly in Gurney Street and northerly in Parker Street, Forsyth Way and easement to Boston Gate House No. 1. Excessive wet weather flows discharge through this gate house to the Back Bay Fens, while lesser wet weather flows and dry weather flows discharge through the 144-in horseshoe-shaped brick conduit, the westerly Foul Flow Channel, along the east bank of the Fens to the MDC Fens Gate House for discharge to the Charles River Basin. A former connection at the MDC Fens Gate House to the easterly Foul Flow Channel and the Boston Marginal Conduit is no longer in operation.

There are many overflow connections to the Stony Brook Conduit from combined sewers, particularly the Stony Brook Valley Sewer, and from the West Roxbury Low Level Sewer. Some of the regulating structures are either partially plugged or not working so that raw sewage is being discharged into the conduit, as described in Appendix D of Vol. 2. There is a substantial flow (not sewage) from the upper portion of the drainage area during dry weather.

The Stony Brook Conduit varies in size and capacity from a 72-in diameter circular, reinforced concrete conduit and less than 100 mgd in Grew Avenue South of Mausur Street to a 316-in x 162-in horseshoe-shaped, reinforced concrete conduit and 1,900 mgd downstream of Huntington Avenue. It is inadequate for its entire length to accommodate the estimated runoff from a 15-year frequency storm over the existing tributary area. Its condition is not known.

Boston Main Drainage Outlet Works

The existing outlet works for the Boston Main Drainage System are presently in use but will be abandoned when the MDC Ward Street and Columbus Park Headworks and tunnel system are in full operation. The section of the Boston Main Interceptor planned to be removed from normal use when the MDC facilities are in full operation extends easterly in Mt. Vernon Street from the Columbus Park Connection near Kosciousko Circle to the Calf Pasture Pumping Station. The Boston Main Drainage outlet works consist of Calf Pasture Pumping Station, Dorchester Bay Tunnel, and Moon Island Detention Facilities. All of these facilities are old and in poor condition.

The Calf Pasture Pumping Station at present contains five pumps of which four are reported to be in operating condition. The present method of operation is to operate four pumps at time of high tide and three at half tide and lower. Three pumps are reported to be rated at 32.8 mgd each and the fourth at 40.8 mgd. The sewage is lifted at the pumping station about 35 ft through force mains to the Deposit Sewers.

The two Deposit Sewers are each 8 ft wide and 16 ft deep and are located east of the pumping station. They are settling tanks about 1/4 mile long extending from the pumping station to the west shaft of the Dorchester Bay Tunnel. The purpose of these tanks is to settle grit from the sewage before it enters the tunnel.

The Dorchester Bay Tunnel is a 7 1/2 ft brick-lined conduit about 7,200 ft long located approximately 142 ft below low water level, and extending from Old Harbor Point to Squantum in the City of Quincy. Three breaks are reportedly existing in the tunnel.

From the east shaft of the tunnel, the Squantum Outfall Sewer extends about 6,000 ft to the Moon Island Detention Facilities. These facilities consist of four storage tanks which have a total estimated capacity of about 35 million gallons when filled to Elev. 20. East of the tanks are twin brick and concrete outlet sewers extending to tide water. Sewage is meant to be discharged through the outlet sewers during the second and third hours of the outgoing tide.

Other Principal Sewers and Conduits

Dorchester High Level Sewer

The Dorchester High Level Sewer serves a separated area of about 750 acres in the south portion of Dorchester adjacent to and north of the Neponset River. The drainage area extends northeasterly from Ruskindale Road, Suncrest Road, and Monponset Street to Walk Hill Street (between Harvard Street and Blue Hill Avenue), and to near Morton Street from the Providence Division of the New Haven Railroad to Gallivan Boulevard. It extends southeasterly from Pleasant Street and Harvard Street (between Roanoke Road and near Walk Hill Street), and Norfolk Street to near Morton Street, to the Neponset River, except for small areas near the river served by the MDC Neponset Valley Sewer.

The Dorchester High Level Sewer extends easterly from its connection to the MDC South Metropolitan High Level Sewer at Monponset Street in River Street through Mattapan Square to Standard Street. At Rector Road near the connection the sewer is 57-in. in diameter of brick masonry and has an estimated capacity flowing full of about 32 mgd. At the connection the sewer is a 54-in by 55-3/4-in modified-circular brick conduit.

The tributary area of the Dorchester High Level Sewer lies in the Dorchester and Hyde Park Improvement Areas. No urban renewal is contemplated in this area.

The sewer is adequate for estimated year 2020 peak dry weather sewage flows. The structural condition of the sewer is not known.

Talbot Avenue High Level Sewer

The Talbot Avenue High Level Sewer serves an area of about 1,300 acres located in the westerly section of Dorchester within the Stony Brook watershed. The drainage area extends generally northeast from Walk Hill Street to Washington Street, Dorchester, and southeast from American Legion Highway to the Midland Division of the New Haven Railroad between Babson Street and Talbot Avenue, with projections southeast from the railroad near Morton Street to the intersection of Morton Street with Gallivan Boulevard, and southwest along American Legion Highway from Walk Hill Street to Cummins Highway. The drainage area is sewered on the separate plan.

The tributary area lies principally in the Dorchester Improvement Area, with a small portion in the Roslindale Improvement Area. No renewal projects are currently under consideration within the area.

The Talbot Avenue High Level Sewer extends northeast from its connection to the MDC South Metropolitan High Level Sewer at Cummins Highway, north of American Legion Highway to east of Walk Hill Street, thence easterly to south of Franklin Field, and northerly to the west slope of Mt. Bowdoin.

The estimated capacity of the Talbot Avenue High Level Sewer for the estimated year 2020 peak dry weather flow rates of sewage flow is inadequate downstream of Lyford Street, at the upper end of the existing 51-in brick sewer. At Lyford Street upstream of the 51-in section, the estimated capacity flowing full of the 42-in is about 20 mgd. At its connection to the South Metropolitan High Level Sewer the sewer is a 51-in circular brick conduit with an estimated capacity flowing full of about 16.5 mgd. The structural condition of this conduit is not known.

East Boston Low Level Sewer System

The East Boston Low Level Sewer system, including a principal branch, the Moore Street Sewer, serves an area of about 250 acres which includes the portion of East Boston generally northeast of Curtis and Harmony Streets, exclusive of an area at the summit of Orient Heights and the area along Saratoga Street east of Barnes Avenue, which are served by separate sanitary sewers connected independently to the MDC North Metropolitan Trunk Sewer. The area is served on the combined sewer plan, although there are some separate drains and sanitary sewers.

The Low Level Sewer extends easterly from a connection to the MDC sewer upstream of the MDC Addison Street Pumping Station through marshland to Boardman Street near Orient Heights, thence southeasterly and easterly to east of Orient Heights. The Moore Street Sewer extends southeasterly in Trident Street, southwesterly along Orient Heights Beach and Coleridge Street to Moore Street, thence northeasterly to McClellan Highway.

The principal outlet for mixed sewage and storm water from the Low Level Sewer system is at the south end of Moore Street.

The tributary area served by the East Boston Low Level Sewer lies in the Orient Heights Improvement Area. No active urban renewal projects are under consideration.

The sewer in Boardman Street is a 36-in diameter brick conduit with an estimated capacity flowing full of about 8.3 mgd. Before entering the Addison Street Pumping Station the sewer is a 39-in by 54-in oval-shaped brick conduit with an estimated capacity flowing full of about 16.5 mgd.

The East Boston Low Level Sewer is adequate in capacity for estimated year 2020 peak dry weather sewage flows, but is inadequate for estimated flows from the 15 year design storm. The physical condition of the pipe line is not known.

Muddy River Conduit

The Muddy River Conduit is the principal conduit serving about 7 sq miles of area in northeastern Brookline and the northwestern Jamaica Plain and Back Bay sections of Boston. The drainage area of Muddy River in Brookline includes in addition to local areas, major areas such as the Chestnut Street area, the Village Brook area at Leverett Pond, the Longwood Avenue area, the Tannery Brook near Aspinwall Avenue, and the Sargents Pond area which drains through the Jamaica Pond drainage area in Boston. The Village Brook area receives flow also from a small area in Brighton.

The conduit consists of twin 72-in reinforced concrete pipes from the open watercourse of Muddy River west of Riverway to Brookline Avenue. It extends northeasterly as a single 108-in x 132-in oval-shaped wood and concrete conduit to Kenmore Square, thence beneath the MBTA subway tunnel as a twin 40-in x 48-in U-shaped reinforced concrete pipe siphon, and northerly in Deerfield Street as a 108-in x 132-in oval-shaped concrete conduit to the Charles River Basin. A 84-in x 108-in branch conduit is joined to twin 72-in reinforced concrete pipes to extend from Brookline Avenue to open water 300 ft east. A major branch is connected to the drain at Jersey Street, and overflow sewers from combined sewers in Beacon Street connect at Kenmore Square.

Flooding along the Muddy River and in its vicinity has occurred to greater or lesser extent for many years, including significant floods in 1955, and in 1962 when flooding was felt as far as Kenmore Square.

Studies of the Muddy River drainage area are included in the comprehensive Charles River Watershed Study now being prepared by the Corps of Engineers. The Boston portion of the drainage area is located in the Parker-Hill Fenway GNRP Area. The upstream end of the conduit will be affected by construction of the Inner Belt Expressway now under design.

Outlets and Appurtenant Facilities

The term "outlet" is used in this report to include all components of the conduit system for the diversion, transmission and discharge of mixed sewage and storm water to the receiving water from a combined sewer, and also for the discharge from a storm drain.

Descriptions in detail of the outlets from the Boston systems are presented in Table 1 of Appendix D. The locations of outlets, coded to the numbered descriptions, are indicated on the sheets of Fig. 4, and are shown on Fig. A, appended to this volume. Estimates of hydraulic capacity of the outlets are included in Table 1.

The outlet from a combined sewer comprises the diversion structure at the sewer with its regulating device, a back flow prevention gate if necessary, a connecting pipe, an outlet sewer serving one or more diversion structures, and a point of discharge to the Charles River Basin or to Boston Harbor or its tidal estuaries.

The diversion of the flow of mixed sewage and storm water in excess of the capacity of the interceptor or in excess of the rate of flow it is desired to discharge to the interceptor is made by regulator devices. The three types commonly installed in the Boston Main Drainage System and the Boston combined sewers connected to MDC branch sewers in East Boston, Charlestown, Brighton and Back Bay, are designated as weir, sump and high-outlet regulators. None of the originally installed mechanical regulators consisting of float-actuated shutter gates or sector shear gates were found still in use during our examination.

The weir-type regulator consists of a low, broad crested weir or dam in the combined sewer and a short connecting pipe to the interceptor. The connection acts essentially as an orifice or short tube to divert all flow to the interceptors below the rate corresponding to the hydraulic head between the sewage level at the dam crest and the level of the hydraulic grade line in the interceptor. At higher rates of flow the amount of mixed sewage and storm water conveyed to the interceptor may increase or decrease, as the net head changes with increasing depths in the combined sewer and in the interceptor. The excess flow is discharged over the dam to the outlet conduit.

In some instances, because of the relative elevations of the interceptor and a combined sewer constructed earlier, the intercepting sewer masonry itself has become in effect the dam in the combined sewer.

The sump-type regulator consists of a sump or depression in the invert of the combined sewer and a short connecting pipe from it to the interceptor. The connection, as for the weir-type regulator, acts essentially as an orifice or short tube to divert all flow to the interceptor at all rates less than the rate corresponding to the level in the sump at which flows pass downstream. At higher rates, the amount of mixed sewage and storm water conveyed to the interceptor may increase or decrease as the net hydraulic head between the level in the combined sewer and the level of the hydraulic grade line in the interceptor changes. The balance of mixed sewage and storm water flow continues across the flooded sump in the diversion chamber into the outlet conduit.

The third type, the high-outlet orifice type regulator consists of the open end of a pipe connected to the outlet sewer extended through the wall of the diversion chamber of the combined sewer above the invert. In this case, the dry weather flow normally continues through the diversion chamber to the interceptor. Under storm conditions as the level in the combined sewer rises with increasing rates of flow and rising hydraulic gradient in the interceptor, the water level in the combined sewer becomes higher than the invert of the connecting sewer entrance, resulting in the discharge of a portion of the mixed sewage and storm water to the outlet conduit. The balance of the flow passes to the interceptor. The rate of flow diverted depends upon the relative hydraulic grade line elevations in the outlet conduit and the interceptor, and the dimensions of the connecting pipe.

Regulating devices also include stop-logs and sluice gates for closure of the diversion connections.

The combined sewers and dry weather interceptors thus were designed with facilities to prevent the inflow of tide water by the installation of tide gates, either singly or in pairs in tandem, or by two or more gates in parallel. The provision of gates in tandem was meant to increase the reliability of operation in the expectation that both gates would not be obstructed by debris at the same time. As described hereafter, many of these facilities are not in operating condition, thus preventing them from serving their intended purpose.

In some instances back water gates are installed on the connections downstream of regulators to prevent inflow to the interceptors from surcharged outlet conduits overloaded by mixed sewage and storm water from upstream sources.

The back water gates consist of hinged flaps of wood or solid metal in gate chambers. Gates are hinged to swing vertically, or in a few cases, at a small inclination from the horizontal. No pontoon-type gates (metal sheets on structural frames) were observed.

The outlet conduit receives the mixed sewage and storm water from one or several combined sewers and possibly one or more storm drains, and conveys the flow to the point of discharge at the shore line or a short distance offshore. Waters which receive such discharges include the Inner Harbor and Dorchester Bay or their estuaries, the lower Charles, Chelsea and Neponset Rivers. The outlets from the combined sewers in the Stony Brook system and the West Side Interceptor districts are connected to the MDC Boston Marginal Conduit, and may discharge to the Charles River Basin or to the Charles River estuary as determined by tide height and available conduit capacity.

Other appurtenances of the outlet systems include junction chambers ("bellmouths"), inverted siphons, and weir troughs. Recommended improvements to outlets and appurtenances are discussed in Chapter VIII.

IV THE METROPOLITAN SEWERAGE SYSTEM

General Description

The Metropolitan Sewerage System, initiated in 1889 with the construction of the Charles River Valley Sewer, was placed under the jurisdiction of the MDC in 1919, and now serves about 152 sq. mi. in 40 cities and towns in the Boston metropolitan area, including the City of Boston. The Boston Main Drainage System was made a part of the Metropolitan Sewerage System by Chapter 645 of the Acts of 1951 for the purpose of sewage disposal. All sewerage facilities in Boston, except for those constructed by or specifically transferred to the MDC, are owned and maintained by the City but are subject to operational requirements of the MDC.

All areas of Boston are served by the Boston Main Drainage System or directly by connections to the Metropolitan Sewerage System. When the Ward Street and Columbus Park Headworks, the Boston Main Drainage Tunnel, and the Deer Island Pumping Station and Sewage Treatment Plant have been put into full operation, the Boston Main Drainage District will be wholly served by the MDC disposal facilities. At the same time, the sanitary sewage from Brighton and portions of the Back Bay and Fenway sections of Boston now connected to the Charles River Valley Sewer and the Ward Street Pumping Station will have been diverted to the Ward Street Headworks and by tunnel to Deer Island. When the Chelsea Headworks and the North Metropolitan Relief Tunnel are in full operation, the Charlestown and East Boston sections will continue to be served at Deer Island. The balance of the area in Boston now served by the South Metropolitan High Level Sewer, exclusive of the area served by the Charles River Valley and the South Charles Relief Sewers, will continue to be served by the High Level Sewer and the Nut Island Sewage Treatment Plant.

The locations of these MDC facilities are indicated on Fig. A which is appended to this volume and on the several sheets of Fig. 4 in Appendix B (contained in Vol. 2). Connections from the City of Boston to the Metropolitan Sewage System are discussed in Chapter X and are shown on Fig. E which is appended to this volume and in Appendix E of Vol. 2.

South Metropolitan Sewerage System

The MDC sewers serving areas in Boston south of the Charles River are the Charles River Valley and the South Charles Relief Sewers, the South Metropolitan High Level Sewer, and the sections of the Neponset River Valley Sewer east and west of the High Level Sewer. Metropolitan sewers which pass through but do not serve Boston areas are the Newton-Brighton Branch Sewer and the Wellesley Extension Relief Sewer. All sewage flows from this system receive primary treatment at the Nut Island Sewage Treatment Plant before being discharged to the harbor.

Charles River Valley Sewer and South Charles River Relief Sewer

The Charles River Valley Sewer and a sewer providing supplemental capacity, the South Charles Relief Sewer, extend along the south bank of the Charles River in Brighton east to near Soldiers Field, and southeasterly to the south bank of the river upstream of Boston University Bridge. The Charles

River Valley Sewer continues southeasterly to the Ward Street Pumping Station and Headworks. The relief sewer crosses the Charles River Basin south of the Cambridge Street Bridge and continues on the north bank to near B.U. Bridge, thence crosses again to the south side and connects to the Ward Street Pumping Station and Headworks. These sewers serve Boston areas in Brighton and portions of Back Bay and the Fens in addition to municipalities upstream. When the North Metropolitan Sewerage System is placed in full operation, all flows in these two sewers will be diverted from the South Metropolitan Sewerage System and the Ward Street Pumping Station will be abandoned.

West of the B.U. Bridge in Cambridge is the site of the planned MDC storm water detention chamber. This chamber is planned to receive flows of mixed sewage and storm water through connections from the South Charles Relief Sewer and north through a siphon from the Charles River Valley Sewer as well as discharges from a planned future North Charles Relief Sewer.

South Metropolitan High Level Sewer

The South Metropolitan High Level Sewer, the trunk sewer of the MDC system south of the Charles River, extends from the north slope of Parker Hill where it receives flow from the Ward Street Pumping Station, south through Jamaica Plain and Hyde Park to the Neponset River west of Blue Hill Avenue and thence through Milton and Quincy to the Nut Island Sewage Treatment Plant. When the Deer Island treatment works are in full operation, the South Metropolitan sewer will receive no sewage from the Ward Street Pumping Station. The High Level Sewer will then serve Boston areas in West Roxbury and Hyde Park and portions of South Dorchester only which are generally sewered on the separate plan.

Neponset River Valley Sewer

The Neponset River Valley Sewer, as built in 1896-97, extended in Boston from near the southwest boundary of Brookline south through West Roxbury and easterly through Hyde Park and Dorchester to join the Dorchester Interceptor which is part of the Boston Main Drainage System, at Granite Avenue. Upon the completion of the South Metropolitan High Level Sewer in 1904, the section of the Neponset River Valley Sewer west of the High Level Sewer was connected to it. That section now serves Boston areas in portions of West Roxbury and Hyde Park, sewered on the separate plan.

The section of the Neponset River Valley Sewer east of the High Level Sewer remains connected to the upper end of the Dorchester Interceptor. It serves small Boston areas north of the Neponset River in Dorchester, and two small areas south of the river in the Town of Milton. Adjustments in charges are made between the City and MDC for service.

North Metropolitan Sewage System

All sewage flows from the North Metropolitan Sewerage System will receive primary treatment and chlorination at the Deer Island Sewage Treatment Plant when it is placed in full operation. This system, in Boston, Consists of the Charlestown Branch Sewer, East Boston Branch Sewer System, North Metropolitan Trunk Sewer, Boston Main Drainage Relief Sewer, Columbus Park Connection, sewer tunnels and headworks and Deer Island facilities.

The Charlestown and East Boston districts of the City are served by connections to branches of the MDC sewerage system connected to the North Metropolitan Trunk Sewer. The upstream section of the trunk sewer and a supplemental conduit, the North Metropolitan Relief Sewer, are connected to the Chelsea Headworks. The downstream section of the trunk sewer, and the North Metropolitan Relief Tunnel connect the headworks with the Deer Island pumping facilities and Sewage Treatment Plant. The MDC branch sewers in Charlestown and East Boston function in a manner similar to that of the interceptors of the Boston Main Drainage System in receiving sewage flows in dry weather. In wet weather, the sewers receive mixed sewage and storm water at rates up to the capacities of the sewers. The excess flow is rejected through outlets to adjacent waters.

Charlestown Branch Sewer

Charlestown which has a combined sewer area of about 500 acres, is served by the Charlestown Branch Sewers in Rutherford Avenue and in Main Street, and by the downstream portions of the MDC Cambridge and the Somerville-Medford Branch Sewers. Sewage from these branches is lifted at the Alford Street Pumping Station and discharged to the North Metropolitan Trunk Sewer in Everett. One Charlestown Branch Sewer extends south from its junction with the Cambridge sewer in Rutherford Avenue and along the south shore of the Charlestown area easterly to Medford Street. The second, a short branch sewer, extends southeast from Sullivan Square in Main Street to Beach Street. Outlets for mixed sewage and storm water discharge (1) to the Mystic River at Beach Street, at the Barry Playground, and at Chelsea Street, (2) to the Inner Harbor at the Navy Yard, Hoosac Pier No. 1, Charles River Avenue, and Warren Avenue, and (3) to the Millers River.

East Boston Branch Sewer System

The East Boston Branch Sewer System serves the portion of East Boston southwest of the Addison Street Pumping Station. The area of about 620 acres is sewered on the combined plan. The principal branch sewer extends generally southwest in Chelsea Street and Bremen Street from near the pumping station to Porter Street, and southwesterly in Bremen Street and Orleans Street and easterly in Marginal Street to Ruth Street. At Porter Street it is joined by a branch northwest to Central Square from which branches extend north in Border Street to Condor Street, and south in Border Street and New Street to Summer Street. At Maverick Street the sewer in Orleans Street is joined by a branch extending easterly to Jeffries Street. Overflows from the combined sewers of this system outlet to Chelsea River, and to the Inner Harbor.

North Metropolitan Trunk Sewer

The North Metropolitan Trunk Sewer east of the Addison Street Pumping Station extends easterly through East Boston south of Orient Heights to the siphon at Belle Isle Inlet and thence across Winthrop to Deer Island. The sewer between the pumping station and Belle Isle Inlet receives inflows from the portion of East Boston east of Boardman Street. These areas are sewered on the separate plan.

Boston Main Drainage Relief Sewer

The recently constructed MDC Boston Main Drainage Relief Sewer extends about 4,800 ft westerly from its Camden Street junction with the Main Interceptor and the Stony Brook Interceptor in Tremont Street, right-of-way, Columbus Avenue, Ruggles Street, Huntington Avenue and Vancouver Street to a junction chamber where it joins the Charles River Valley Sewer and the South Charles Relief Sewer and near the Ward Street Headworks. The conduit is a 6 ft 6-in cast-in-place concrete tunnel for most of its length. The invert slope is 0.001 and the estimated capacity flowing full is about 105 mgd.

The purpose of this relief sewer is to divert peak dry weather flows from the West Side and Stony Brook Interceptors of the Boston Main Drainage System to the Ward Street Headworks and thence to Deer Island. Under certain hydraulic conditions, flows from the East Side Interceptor also may be diverted westerly through the Main Interceptor to the conduit and thence to Ward Street. The Boston Main Drainage Relief Sewer was placed in partial operation in May 1967.

Columbus Park Connection

The recently constructed 116-in by 87-in horseshoe-shaped Columbus Park Connection conduit extends north from the junction chamber at the Boston Main Drainage Interceptor in Mt. Vernon Street about 3,500 ft to the Columbus Park Headworks. At the junction chamber currently under construction at the point of diversion of flow from the Boston Main Interceptor to the Columbus Park Connection, there is a 45 ft weir with its crest about 6.2 ft above the invert, adjustable within a limited range, and a 4' - 0" wide opening for stop logs. Flow discharged over the weir or through the opening will continue east in the Main Interceptor toward the Calf Pasture Pumping Station. The estimated capacity of the Columbus Park Connection under operating conditions with the water surface at Elev. -9.7 at the entrance to the Headworks and at the level of the weir crest at the junction chamber is about 180 mgd. With a surcharge on the weir, additional flow will be able to pass through the connection conduit. The conduit flowing full with the hydraulic slope parallel to the invert slope is estimated to have a capacity of about 135 mgd.

If operation of the Calf Pasture Pumping Station is discontinued after diversion has been accomplished, there will be no overflow capacity available for emergency use to relieve the Columbus Park Headworks. If such an overflow were not available in an emergency, the sewage in the Boston Main Interceptor would be caused to back up in the nearby branch interceptors (Dorchester and South Boston Interceptors) and discharge through the Dorchester Brook Conduit and the Roxbury Canal to Fort Point Channel and at the existing outlets.

Sewer Tunnels and Headworks

Recent improvements to the Metropolitan System include the construction of two deep rock sewer tunnels and three headworks. The North Metropolitan Relief Tunnel extends southeasterly from the Chelsea Creek Headworks about 20,800 ft to a shaft at Deer Island Sewage Treatment Plant. This tunnel is 10 ft in inside diameter and is about 300 ft below mean sea level.

The Boston Main Drainage Tunnel extends generally easterly from Shaft A at Ward Street, Roxbury, about 13,800 ft at 10 ft in diameter to Shaft B at Columbus Park, South Boston, thence about 23,800 ft at 11-1/2 ft in diameter to Shaft C at the Deer Island Pumping Station. This tunnel is also about 300 ft below mean sea level. The maximum capacity of the Boston Main Drainage Tunnel is estimated to be about 440 million gallons per day operating surcharged.

The headworks at Chelsea Creek, Ward Street and Columbus Park each include mechanically cleaned coarse and fine bar racks, screenings removal equipment, grit chambers, Parshall flumes, and metering instrumentation with signals relayed to the pumping station at Deer Island for sewage level control.

Deer Island Facilities

The Deer Island facilities of the MDC include the old Winthrop Pumping Station which pumps from the North Metropolitan Trunk Sewer and the Deer Island Sewage Treatment Plant. The sewage treatment plant includes a large new pumping station which pumps from the terminal shafts of the Boston Main Drainage Tunnel and the North Metropolitan Relief Tunnel. The new pumping station is now in partial operation but the remainder of the treatment plant has not been placed in service. The new pumping station has a total installed capacity of about 790 mgd, and the old station pumping from the Trunk Sewer has a capacity of about 135 mgd.

The treatment plant has design capacity to treat an average daily sewage flow of 343 mgd and total hydraulic capacity of 849 mgd. The treatment plant provides primary treatment with separate sludge digestion and chlorination of the effluent. The equipment includes that required for sedimentation, sludge thickening, sludge digestion and storage, recovery and storage of sludge gas and for application of chlorine for disinfection. Two outfall pipes extending to the vicinity of Deer Island Light in the President Roads channel at about 50 ft depth have a combined capacity of about 534 mgd, and with two relief discharge outlets near the shore line a total discharge of 924 mgd is provided. Provisions have been made to discharge digested sludge through the outlets with the effluent.

Boston Marginal Conduit

The Boston Marginal Conduit, completed in 1910 as part of the construction of the Charles River Basin and Dam by the Charles River Basin Commission, is now the responsibility of the MDC Parks Division. The conduit extends along the south bank of the Charles River Basin from Charlesgate easterly to Charles River Dam at Leverett Circle. At Charlesgate it is connected to the gate house at the lower end of the Foul Flow channels of the Stony Brook system, described hereinbefore as part of the Boston Sewerage System, and at the Charles River Dam it discharges to the harbor at the upper end of the Charles River tidal estuary.

In addition to discharges from the Stony Brook system, the conduit receives overflows of mixed sewage and storm water from the West Side Interceptor system at Hereford, Fairfield, Dartmouth, and Berkeley Streets, Beaver Place, Mt. Vernon, Pinckney, Cambridge, Fruit and Allen (Poplar) Streets, at the Charles River Dam (opposite former Chambers Street) and opposite Leverett Street immediately upstream of the outlet at the Charles River Dam.

The Boston Marginal Conduit discharges under certain conditions of storm and tide to the Charles River Basin through outlets with back water gates at the gate house at the Fens, at a connection immediately upstream of the locks at the Charles River Dam, and by overflow structures near Gloucester Street, near Exeter Street, east of Berkeley Street, north of Mt. Vernon Street, and north of Cambridge Street. The discharges from the conduit to the basin occur by passing over weirs with crests set at Elev. 8.5. (Boston City Base).

The Conduit for much of its length is a reinforced concrete horseshoe-shaped section 76-in wide x 92-1/4 inches high. The total length of the conduit is approximately 9,800 ft, including 575 ft across the Charles River Dam in an enlarged section 12 ft wide x 10 ft high, and a tide gate chamber. The standard section is interrupted between Mt. Vernon and Dartmouth Streets by later reconstruction of approximately 2,340 ft of 96-in diameter pipe. The conduit is carried on a level grade with its invert at Elev. -1.5, so that the crown of the standard section is thus about 2 ft below the controlled water level in the Charles River Basin (Elev. 8.0) and about 0.4 ft above mean tide level in the Harbor, (Elev. 5.83).

V BASIS OF DESIGN

General

In order to abate the pollution of Boston Harbor and adjacent waters, all flows of sewage from areas tributary thereto must be intercepted and carried to suitable locations for disposal.. Furthermore, the discharge of mixed sewage and storm water from combined sewerage systems to these bodies of water must be reduced to a minimum.

Sewage from lateral, branch and submain sewers is normally intercepted by means of intercepting sewers designed to receive all tributary flows of sanitary sewage, infiltration and industrial waste, as described hereinafter. Such intercepting sewers are known as dry weather interceptors and for this study have been designed with capacity sufficient for peak sewage flows expected to occur in the year 2020. Relief sewers, where required for either dry weather or combined flows, have been designed so that the total capacities of both the existing and relief conduits will also be sufficient for expected peak flows.

Overflows of untreated mixed sewage and storm water from areas now served by combined sewers may be prevented under normal circumstances by one of two general methods: (1) complete separation of all storm drainage and sanitary sewerage systems in presently combined areas, or (2) interception of overflows of mixed sewage and storm water prior to their discharge into the receiving body of water. These methods are described in detail in Chapter VII and Appendix F.

Existing Sewers and Conduits

Existing sewers and conduits requiring relief or rehabilitation are those which, either because of insufficient hydraulic capacity or from evidence of structural deterioration, require remedial work to enable them to function as fully effective parts of the City of Boston sewerage system. These sewers and conduits, however, must be in such condition as to permit economical rehabilitation. Those which are considered to be not in such condition as to permit economical rehabilitation must be replaced as discussed hereinafter. We have estimated the hydraulic capacities of existing principal sewers and conduits to determine their adequacy under full-flow conditions, assuming that they are cleaned and repaired to permit full utilization of their flowing-full capacities. For estimating these capacities, we have assumed Manning's "n" values of 0.017 for sewers and conduits of brick, wood, stone, clay, plain concrete, iron and undetermined materials and 0.015 for those of vitrified clay and reinforced concrete.

New sewers and conduits have been designed wherever existing principal sewers and conduits are inadequate to carry estimated design flows or wherever there is evidence of structural deterioration. We consider that much of the existing Boston Main Drainage System, including tributary sewers, will complete its useful life and require relief or replacement by the year 2020 either for hydraulic or structural reasons. Rehabilitation of existing interceptors and conduits is, in our opinion, justified only for maintaining service until adequate replacement facilities can be constructed or, in specific cases, where inspection indicates that the sewer or conduit is worthy of repair.

Manhole rim, crown and invert elevations of all existing principal interceptors in the Boston Main Drainage System have been obtained from field surveys conducted by Camp, Dresser & McKee for this study. From these surveys as well as from sewer profiles available in the offices of the Sewer Division, and from observations of liquid levels in manholes, we have determined slopes for estimating the hydraulic capacities of the existing sewers. It was found that there are discrepancies between the elevations, slopes and sizes shown by our surveys and those shown on the available record and construction drawings. Our measurements of crown elevations in most cases agreed quite closely with these earlier records, while measurements of inverts, affected by debris and other deposits on the bottom of the interceptors, frequently disagreed. Apparent settlement was noted in several locations, such as at Boylston Street on the West Side Interceptor where total settlement is estimated to be about 3 ft.

Proposed Sewers and Interceptors

All proposed sanitary sewers and interceptors have been designed to carry peak dry weather sewage (sanitary sewage and industrial waste) flows, including the amount of extraneous flows expected for the year 2020. However, where proposed sewers or conduits are required to carry some storm water, they have been designed to carry the required portion of the estimated runoff for a 15-year frequency design storm in addition to the peak dry weather flow of sewage (i.e. storm water runoff plus sanitary sewage and industrial waste).

Proposed interceptors for relief or replacement have been designed to carry the estimated peak dry weather sewage flows, utilizing about 90 per cent of their flowing-full capacities. Sewers other than interceptors have been designed to carry the estimated peak rates of sewage flow, utilizing the following percentages of their flowing-full capacities:

8-in to 12-in	50%
15-in to 18-in	60%
21-in to 30-in	70%
Greater than 30-in	90%

Proposed conduits which will carry both dry weather and storm water flows from their tributary areas, have been designed to flow full.

All sewers are proposed to function as gravity pipelines and will be constructed at slopes sufficient to maintain at least the minimum self-cleansing velocity of 2 fps (feet per second) when flowing full. A Manning's formula "n" of 0.013 was used in the design of these sewers. All proposed sewers are to be constructed at depths required to serve contributing sewers.

It is proposed that, in general, sewers 18-in. in diameter and larger be constructed of reinforced concrete and that vitrified clay pipes be used for smaller sizes. In order to minimize infiltration of ground water, preformed compression joints are recommended. It is further recommended that all tide water be positively prevented from entering sewers either by means of properly operating tide or sluice gates or by elimination of direct connections between tide water and the sewerage system.

Proposed Conduits and Tunnels

Conduits and tunnels for transmission and storage have been designed for mixed sewage and storm water overflows, as discussed below.

Overflow control structures have been designed to permit flows in excess of dry weather interceptor capacities to be discharged in the future to the proposed deep tunnels. Emergency relief outlets have been provided at selected outlet interception chambers on the proposed South Boston Pollution Control Conduit.

Surface storm conduits have been designed with capacities sufficient to carry the estimated runoff from tributary areas for a 15-year frequency rainfall intensity as discussed in detail hereinafter. Such conduits have been designed to flow full at slopes sufficient to provide a velocity of 3 fps. All conduits up to 18-in. in diameter are proposed as vitrified clay or concrete pipes, and those 18-in and over as reinforced concrete pipe except where reinforced concrete box culverts or other sections are required. A Manning's formula "n" of 0.013 was used for the design of all proposed conduits.

At junction manholes where increments of flow are to be introduced, the invert elevation of the downstream pipe has been dropped below that of the upstream pipe a sufficient amount to allow for increase in the depth of flow and friction losses at the junction.

The basis of design for the proposed Deep Tunnel Plan is discussed in Chapter VII and Appendix F. Transmission tunnels for overflows of mixed sewage and storm water have been designed in the same manner as the surface storm conduits described above. Storage tunnels have been designed with volume sufficient to store the required volume of runoff from a 5-in rainstorm of 15-year frequency and 1 day duration with tunnels filled to capacity without surcharging. An ocean outfall and diffusers for the discharge and dispersion of flows of mixed sewage and storm water pumped from deep storage tunnels have been designed for a minimum sea water dilution rate of 200 to 1 at the nozzles.

Sanitary Sewers

In order to evaluate the adequacy of the existing City of Boston sewerage system, and particularly that portion served by the Boston Main Drainage System, and to determine the requirements for improvements to this system, it was necessary to estimate the present and future rates of sewage flow for the city. Sewage is defined as any waste water from homes, businesses, industries, institutions, etc. which is discharged to the sewerage system, together with other liquid components which inevitably become a part of the total sewage flow. Such other components consist of storm water, ground water and tide water, and are commonly referred to as "extraneous flows." For the design of new sanitary sewers and dry weather interceptors and to increase the effective capacity of existing interceptors, extraneous flows should be reduced to the maximum extent practicable, as discussed hereinafter.

Population and Sewage Flow

Sewage, for the purposes of analysis and design, has been subdivided into three major components: sanitary sewage flow, extraneous flow, and industrial wastes. Sanitary sewage is that part of the total sewage flow contributed by domestic, commercial, and light industrial (not wet process) users of the sewerage system. Because of the highly developed nature of the City of Boston, sanitary sewage is considered to be composed of the sanitary sewage from residents, workers, and transients as defined below:

1. Residents - Those who live in the area, regardless of where they work.
2. Workers - Those who work in the area, regardless of where they reside.
3. Transients - Those who visit the area for business, recreation, or other reasons, for a part of a day.

The amount of sanitary sewage was estimated by means of population and land use projections and water consumption figures, and was checked by the gaging of sewers and by the monitoring of water consumption.

Industrial waste is considered to be that quantity of waste water flow contributed to the City of Boston sewers by many wet process industries in the city. Industrial waste flows were determined from individual water consumption records, and an industrial survey was made for the purpose of estimating the flow from such sources.

Extraneous flow was defined above as that portion of the total sewage flow resulting from the entrance of ground water, storm water and tide water into the sewerage system. Usual sources of extraneous flow are infiltration of ground water into sewer pipes and manholes and storm water from manhole covers and area-way, basement and foundation drainage. The rates of infiltration were determined by gaging City sewers. In portions of the existing Boston sewerage system, tide water leakage through tide gates and outlets is a major source of extraneous flow.

Sewage flow varies continuously throughout the day and seasonally throughout the year. The adequacy of a sewerage system is based upon its ability to carry all rates of sewage flow throughout the year. Because of (a) the magnitude, (b) the long life, and (c) the high cost and difficulty of modifications of various pipes and other works required to collect sewage, proposed new sewers have been designed with capacity to handle expected flows for about 50 years in the future, or until the year 2020. Sewers designed on this basis may serve satisfactorily for many years beyond this date.

Population Trends

Studies of the United States Census and Massachusetts Decennial Census were made to determine past population trends for the City of Boston and for each of the 22 wards comprising the city. In projecting ward populations through the design period to the year 2020, no single method has been used. Estimates of future population have been based upon earlier local and regional population studies by others, together with available data on present and future land use.

Projections used in this study considered the effects of the following special factors:

1. Implementation of the Boston Development Program and private development projects with resultant changes expected in location and growth patterns of populations and of commercial and industrial activity in the city.

2. Increasing use of private transportation, particularly automobiles, as means of entering and leaving the city.

3. Implementation of plans of the Massachusetts Bay Transportation Authority (MBTA) to extend new rapid transit routes to suburban areas.

4. Completion of the Inner Belt, a major circumferential expressway, and the construction of the proposed Southwest Expressway.

5. Maintenance of a climate attractive to new public and private investment in commercial, industrial and residential activities.

6. Improvement of housing and educational conditions, particularly in Boston's older neighborhoods with resultant changes in population density, water consumption and standards of living.

7. Abatement of pollution in Boston Harbor and its estuaries, such as the Charles River, Fort Point Channel and Carson Beach.

8. Continuing increase in the enrollment of institutions of higher learning within the city.

Other less tangible factors, such as redevelopment of the city beyond plans currently in existence and continuing advances in technology, have also been considered.

While forecasts of future population are necessary as a basis for estimating future quantities of sanitary sewage, it is realized that their reliability decreases as the period of forecast is increased. Moreover, the reliability of these projections tends to be greater for larger populations than for smaller populations. Therefore, forecasts of population distribution and density for wards and local tributary areas are usually less reliable than forecasts of population and density of the whole city. Future growth may be heavy in one area, while there may be little growth or even a loss in others. The projected trend of residential population growth used herein for the whole City is based on projections made by the Metropolitan Area Planning Council (MAPC) and the Boston Redevelopment Authority.

Residential Population

Residential population trends for the whole City of Boston are shown on Fig. 6 . We estimate the total residential population in the year 1967 to be approximately 640,000. We anticipate that there will be little net change in the population of the city before about 1970, and that by the year 2000 there may be approximately 767,000 people living in the city, which was a maximum capacity figure estimated by a State agency in 1966.

By projecting the rate of population growth shown for the period 1970-2000, we estimate that the total residential population of the city in they year 2020 may be approximately 850,000. This is shown on Fig. 6 by the "Projected Trend" line and represents the population trend used in this report for the design of necessary facilities. A residential population of 850,000 may be reached as early as year 2000, if the trend shown by the "Upper Limit" line should actually accur.

The upper limit of the envelope of probable future population (shown on Fig. 6 was determined by using an average rate of growth for the period 1965-2000, slightly below the 1960-1975 rate currently planned by the Boston Redevelopment Authority. This lower average rate of growth was used because it seems reasonable to assume that the rate of increase in the total number of residence units in Boston will decrease after 1970, even though the planned rate of redevelopment might continue through the year 2000. The lower limit of the envelope was determined by using 730,000 as the population in the year 2020, based upon the stable population estimated in 1966 by a State agency for its high series projection for the years 1990 through 2000.

Past population trends, shown on Fig. 6 , have been adjusted to allow for the different methods used in enumeration by the Federal Census and by the Decennial Census of Massachusetts. The Federal Census enumerates each person where he is found on the census day, regardless of whether he considers that municipality his permanent domicile or not. The Decennial Census of Massachusetts counts only those persons who claim a domicile in a particular Massachusetts community. Therefore, the population figures have been adjusted from 1950 onward, to include students and institutional personnel residing in the city all year or during the school year, but who may not claim a domicile in the City of Boston.

The United States Bureau of the Census in 1960 prepared statistics on the residential population of Boston by census tracts and by city blocks, based on data from the census of housing taken as of April 1, 1960. Population densities of the census tracts and city blocks were computed from the Census Bureau data and the measured area of each tract and block selected for study.

A summary of existing and projected population of the city by wards is shown in Table 2. Ward limits are shown in Fig. B, appended to this volume. The past record of growth and projected future population

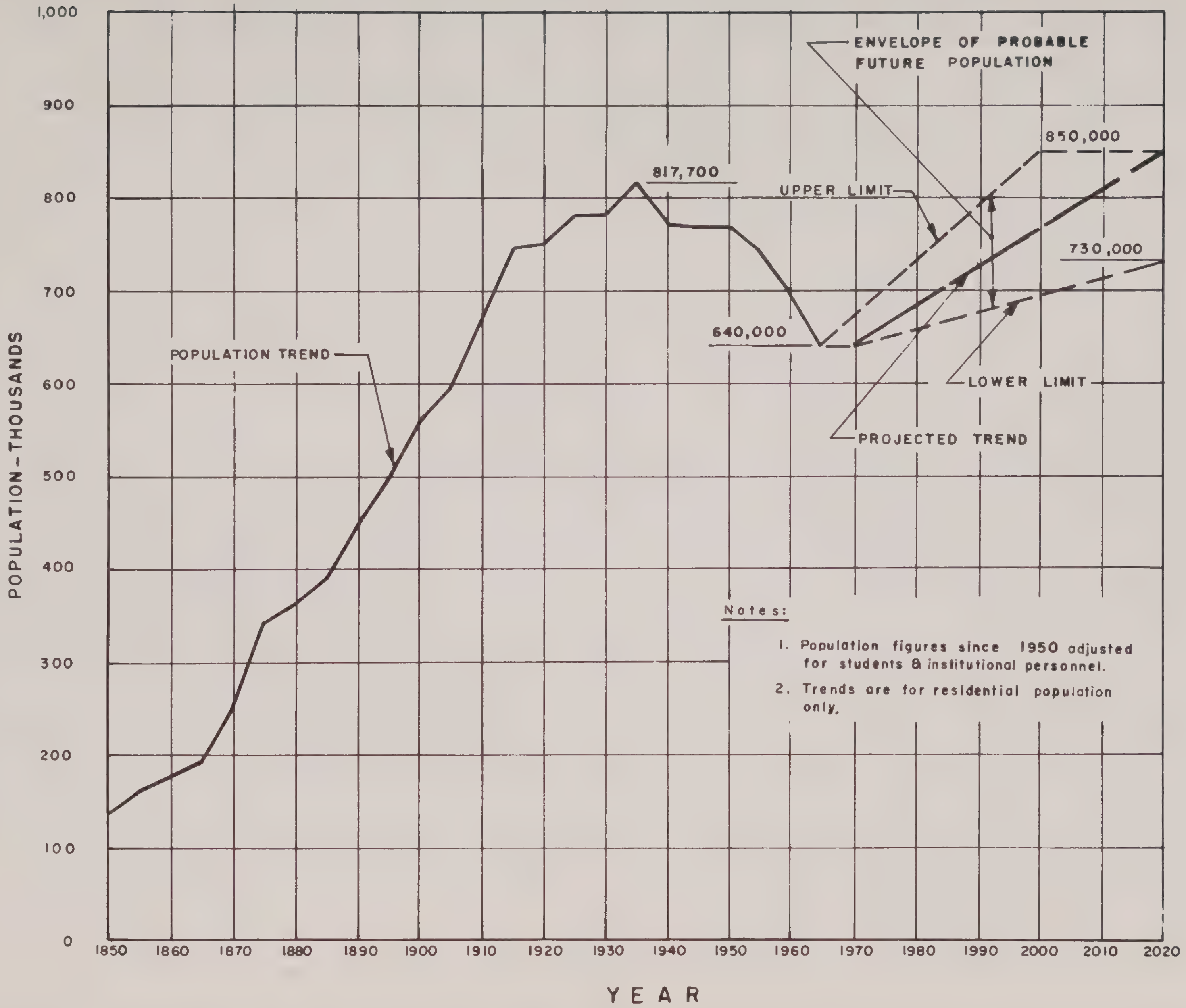

FIG. 6 RESIDENTIAL POPULATION TRENDS FOR BOSTON, MASSACHUSETTS

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TABLE 2 RESIDENTIAL POPULATION TRENDS OF BOSTON BY WARDS

Ward	1967 Population Estimates	2020 Population Projections
1	39,000	47,000
2	18,300	35,000
3	21,800	50,000
4	30,000	55,000
5	28,400	45,000
6	22,600	34,000
7	25,500	32,000
8	17,700	22,000
9	14,800	18,000
10	23,400	32,000
11	22,100	26,000
12	21,300	26,000
13	28,600	32,000
14	47,000	52,000
15	22,500	26,000
16	29,100	34,000
17	30,000	34,000
18	58,200	70,000
19	29,600	38,000
20	46,000	67,000
21	35,400	42,000
22	28,700	33,000
Totals	640,000	850,000

Note: See Plan Fig. B appended to this volume.

trends of wards are presented on Fig. 7 in Appendix C of Vol. 2. Population densities for each ward were computed and, based on these densities, each ward was assigned to one of three residential population density groups: high (H), moderate (M), and light (L).

The density of each tract and city block falling within a given ward was plotted and a family of population density curves for the City of Boston was developed, as shown in Fig. 8. In general, these curves are somewhat higher than those which apply to the present residential population of Boston, inasmuch as they apply to anticipated population at the end of the design period. However, portions of the high and moderage density group curves applying to areas between 2 and 10 acres are valid for apartment buildings of the type presently being constucted, and which are expected to gain in popularity in the future. Data for each of the apartment buildings studies is shown on Table 3.

For sewer design purposes, Table 4 was utilized. Table 4 indicates the various land uses and zoning districts considered applicable to the three design density curves presented on Fig. 8. The zoning districts are those adopted by the Zoning Commission of the City of Boston in its meeting on August 15, 1962. We have used these zoning districts, and the areas to which they apply, in computing tributary population and sewage flow. Our estimates take into account the fact that all zoning districts, except industrial, contain some degree of residential population. For design purposes, persons residing in the downtown area are considered to remain in the area during the course of a normal working day.

Worker Population

To determine the characteristics of Boston's working force population, we have utilized data from the 1964 Cordon Count which was initiated and carried out by the Boston Traffic and Parking Department to investigate present travel patterns and to make comparative studies with similar data collected in the past. The limit of the Cordon Count study area was a line cutting across all points of access to the peninsula of downtown Boston, and cutting across the peninsula at Massachusetts Avenue from the Charles River to the South Bay.

From our analysis of this study, we estimate that the number of workers in the downtown section of the city will be approximately equal to the number of persons entering the area between the hours of 6 AM and 9 AM. While a certain number of transients will no doubt enter the city during this period also, it is felt that this number may be about equal to the number of workers arriving after 9 AM.

Our estimate of the total number of workers which entered the downtown area daily in 1964 is about 240,000. Of this figure, approximately 40,000 were students attending schools in Boston, but living outside of the city during the school year. For our study, we have considered these students as workers.

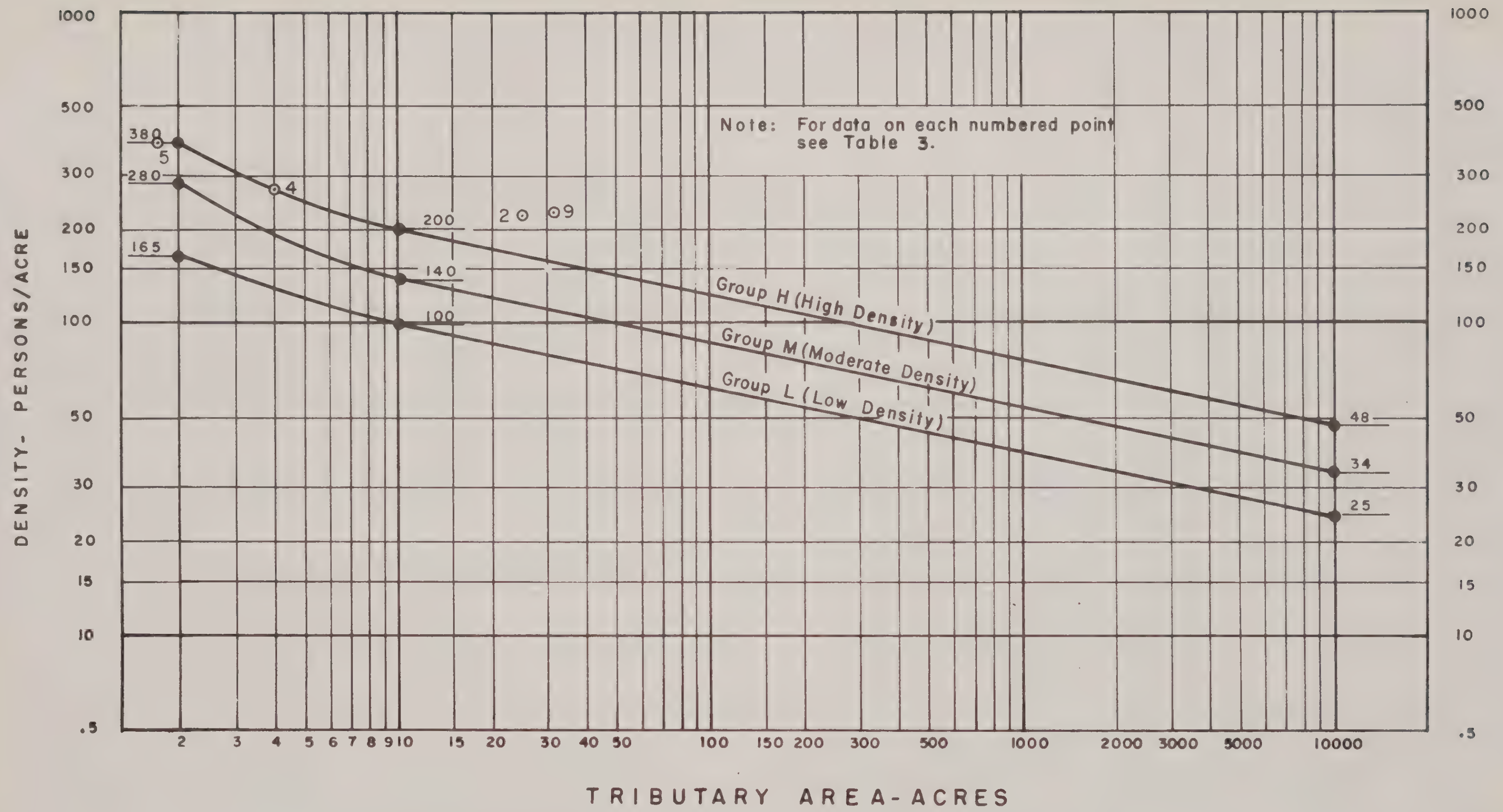

FIG. 8 RESIDENTIAL POPULATION DENSITIES FOR BOSTON, MASSACHUSETTS

TABLE 3 ESTIMATED SEWAGE FLOWS FROM APARTMENT BUILDINGS IN DOWNTOWN BOSTON

Name and Address of Building (1)	Estimated Total No. Persons in Building[a] 1966 (2)	Estimated Total No. Persons in Building[a] Ultimate (3)	Gross Site Area, acres (4)	Ultimate Population Density, Persons/acre (5)	Estimated 1966 Sewage Flow Total cu ft/yr[b] (6)	Estimated 1966 Sewage Flow Average Daily gpd (7)	Estimated 1966 Sewage Flow Average Daily gpcd (8)	Remarks (9)
(1) Belleview Apartments 21 Beacon Street	310	310	0.67	460	1,732,000	35,500	115	-
(2) Charles River Park Apartments, Ultimate	-	5,500	25.20	220[c]	-	-	-	Under construction
6 and 8 Whittier Place	1,170	-	-	-	3,550,000	72,700	62	-
(3) 520 Beacon Street	90	90	0.36	250	265,000	5,400	60	-
(4) Prudential Plaza Apartments 1 and 3	-	1,080	4.02	270[c]	-	-	-	Under construction
(5) River House 145 Pinckney Street	340	670	1.74	380[c]	888,000	18,200	54	-
(6) Tetlow Apartments 11 Tetlow Street and 14 Palace Road	100	130	0.36	360	277,000	5,700	57	-
(7) 330 Beacon Street	125	240	0.70	340	721,000	14,800	118	-
(8) Tremont-on-the-Common 120 Tremont Street	-	750	0.91	820	-	-	-	Under construction
(9) Christian Science Development	-	7,070	31.00	230[c]	-	-	-	Under design

Notes:
(a) Building population figures were obtained from rental agents or building superintendents.
(b) Total sewage flow equals total water consumption less estimated air conditioning losses, where applicable.
(c) Data plotted on Figure 8.

TABLE 4 LAND USE AND RESIDENTIAL POPULATION DENSITY GROUPS

CITY OF BOSTON, MASSACHUSETTS

Residential Population Density Group	Type of District	Predominant Type of Land Use	Zoning* District
L (Low Density)	Residential	Single Family	S-.3
		" "	S-.5
		Two Family	R-.5
	Commercial	Local Retail and Service Stores	L-.5
		" "	L-1
		" "	L-2
		Retail Business and Offices	B-1
		" "	B-2
		" "	B-4
		" "	B-8
		" "	B-10
		Light Manufacturing	M-1
		" "	M-2
		" "	M-4
		" "	M-8
M (Moderate Density)	Residential	Three Family and Row Apartments	R-.8
		" "	H-1
H (High Density)	Residential	Apartments	H-2
		"	H-2-65
		"	H-3
		"	H-4
		"	H-5
(No Residential Population Assumed)	Industrial	General Manufacturing	I-2
		Waterfront Industry	W-2

* Note: Numerals in the zoning district designation indicate the maximum allowable ratio of the gross floor area of all structures on a lot to the area of the lot.

The Boston Redevelopment Authority in its "Summary 1965/1975 General Plan" expects the total employment in the downtown or core area to rise from 280,000 in 1960 to 315,000 by 1975. If this rate were projected to the year 2020, the total employment in the downtown area of the City of Boston would be approximately 420,000 persons, including employees resident in downtown area.

We estimate that in 1967 the daily average number of workers entering the downtown area of the city is approximately 250,000, which includes only those persons entering from other portions of the city and suburban communities. If the ratio of total downtown employment to the entering worker population remains essentially constant through the design period, we estimate that the average worker population in the downtown area in the year 2020 may be approximately 350,000 persons, as shown in Table 5 .

TABLE 5 SUMMARY OF WORKER AND TRANSIENT POPULATION TRENDS IN DOWNTOWN BOSTON

Population Component	Estimated Total Population 1967		Projected Total Population 2020	
	Average Weekday	Maximum Weekday	Average Weekday	Maximum Weekday
Workers Entering	250,000	260,000	350,000	370,000
Transients	300,000	500,000	450,000	750,000
Total	550,000	760,000	800,000	1,120,000

Based on additional retail sales help employed in past years in the downtown area during Christmas rush periods, we estimate that a total of about 260,000 workers will be employed on the maximum weekday in December, 1967, and that this figure will increase to 370,000 in 2020. We estimate that approximately 80 per cent of these workers are employed in office buildings and retail stores with the remainder employed in water-consuming industries. In our hydraulic computations, the average sanitary sewage flow from workers in water-consuming industries is considered as part of the total flow from the industrial area as described under "Industrial Waste Flow."

For use in determining capacity requirements for sewers, we have made estimates of worker population density for downtown areas of the city, as shown on Fig. 9 .

For the year 1975, the Boston Redevelopment Authority estimates that about 690 acres of the downtown or core area of the city will be in commercial use, and that approximately 160 acres will be in industrial use, for a total of 850 acres. We estimate, further, that the portion of the downtown area in commercial use only will increase to approximately 800 acres by the year 2020 and contain approximately 296,000 workers, resulting in a maximum worker density for design purposes of 370 per acre, as shown at the right-hand end of the curve on Fig. 9 . For the left end of the curve, we have obtained data on worker population and gross building site area for ten office buildings and three prominent retail stores in downtown area. The data for each building is presented in Table 6, and the plotted points for each building are as indicated by corresponding numerals on Fig. 9 .

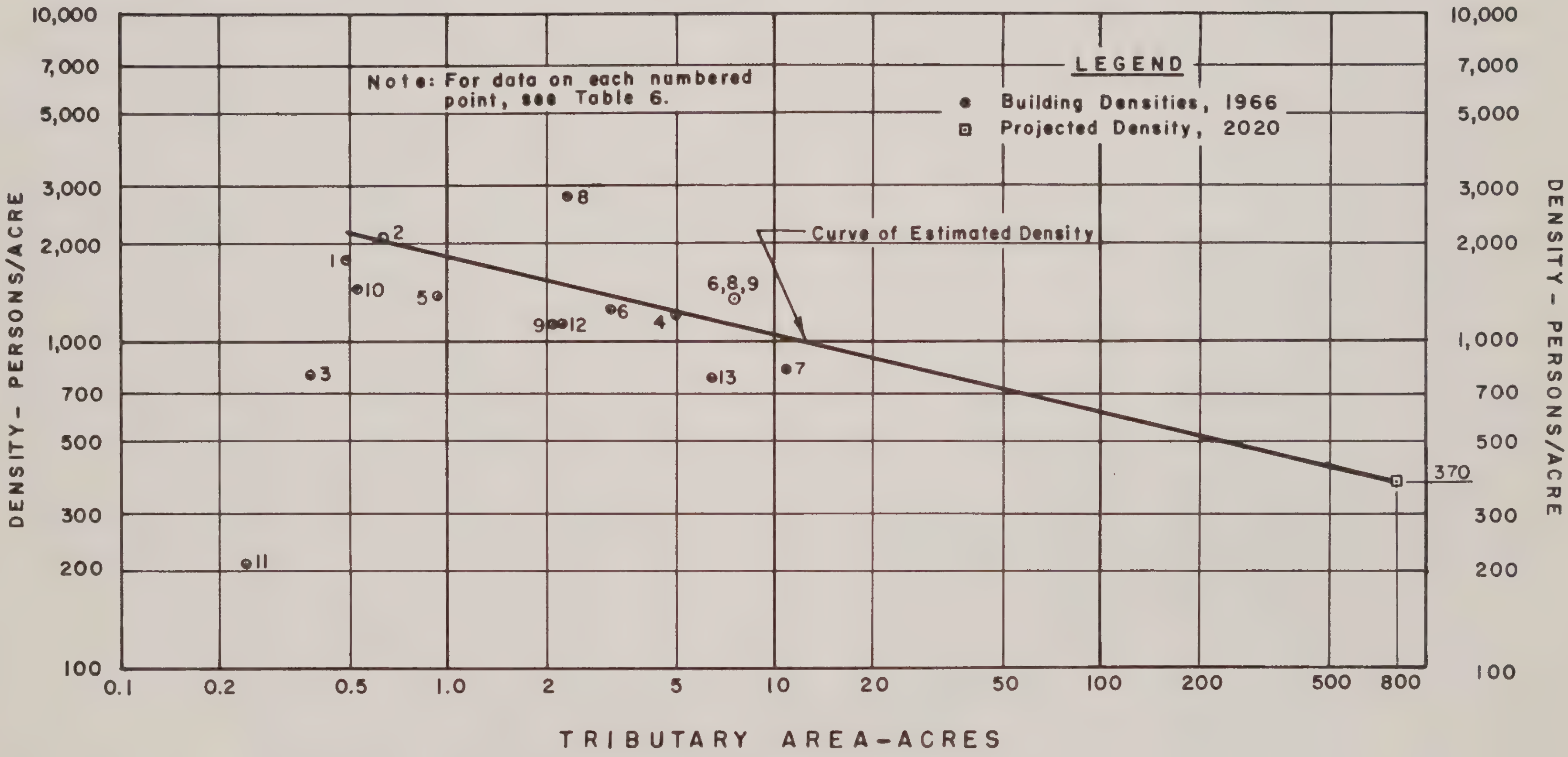

FIG. 9 WORKER POPULATION DENSITY IN DOWNTOWN COMMERCIAL AREAS

257-8376

TABLE 6 ESTIMATED WORKER DENSITY AND SEWAGE FLOWS FROM COMMERCIAL BUILDINGS IN DOWNTOWN BOSTON

Name and Address of Building (1)	Total Metered Water Consumption, cu ft/yr (2)	Average No. Workers/Day in Building		Gross Site Area, acres (5)	Ultimate Worker Density Persons/acre (6)	Estimated 1966 Average Daily Sewage Flows	
		1966 (3)	Ultimate (4)			gpd (7)	gpcd (8)
OFFICE BUILDINGS							
(1) Blue Cross-Blue Shield Building 133 Federal St.	2,874,000	880	880	0.49	1,790	62,600	71
(2) Kimball Building 18 Tremont St.	3,023,000	1,300	1,300	0.63	2,060	90,900	70
(3) John B. Chase 535 Boylston St.	472,000	300	300	0.38	790	11,670	39
(4) John Hancock Building 200 Berkeley St.	10,737,000	6,000	6,000	5.01	1,200	240,000	40
(5) National Shawmut Bank 40 Water St.	2,800,000	1,290	1,290	0.93	1,380	51,700	40
(6) New England Telephone & Telegraph Company 185 Franklin St.	4,756,000	3,330	4,000	3.17	1,260	115,600	35
(7) Prudential Plaza	10,092,000	4,300	9,000	10.9	826	292,000	68
(8) State Street Bank Building 225 Franklin St.	not available	5,500	6,500	2.32	2,800	not available	
(9) Travelers Insurance Building 125 High St.	1,851,000	1,700	2,400	2.13	1,130	40,000	24

TABLE 6 ESTIMATED WORKER DENSITY AND SEWAGE FLOWS FROM COMMERCIAL BUILDINGS IN DOWNTOWN BOSTON
(Continued)

Name and Address of Building (1)	Total Metered Water Consumption, cu ft/yr (2)	Average No. Workers/Day in Building		Gross Site Area, acres (5)	Ultimate Worker Density Persons/acre (6)	Estimated 1966 Average Daily Sewage Flows	
		1966 (3)	Ultimate (4)			gpd (7)	gpcd (8)
OFFICE BUILDINGS (Continued)							
(10) Western Union Building 230 Congress St.	1,160,000	770	770	0.53	1,460c	27,220	35
RETAIL STORES							
(11) Best & Company 510 Boylston St.	55,000	50	50	0.24	210	980	20
(12) Filene's 426 Washington St.	4,679,000	2,500	2,500	2.24	1,120	108,000	43
(13) Jordan Marsh Company 450 Washington St.	8,342,000	5,000	5,000	6.40	780	174,000	35

Note: Worker densities plotted on Fig. 9.

The downtown or core area of the city may be defined as that part of the city containing, or potentially containing, the bulk of regionally, rather than locally, oriented activities. It embraces the Central Business District with its retailing, government, business, and professional services and, in addition, includes the greatest concentration of the region's most valuable land and productive enterprises. The buildings for which estimates of population and water consumption have been made, as shown in Table 6 , were selected as representative of current building space utilization and of future trends in commercial building design and space utilization.

The estimated average number of workers in each building has been based upon information obtained from persons in charge of the buildings, usually the building superintendent. The two columns of worker population figures indicated in Table 6 are for workers estimated to have been actually served during 1966 and for the number of workers for which the buildings were designed. The former figures have been used for estimates of sewage flow and the latter for worker density.

The Western Union, New England Telephone and Telegraph, and National Shawmut Bank Buildings have estimated night worker populations equal to about 10 per cent of their total staff. These night worker populations are included in the figures presented in Table 6 and are primarily engaged in servicing communications systems or operating computers. The other buildings studies have a neglibible number of night-time employees.

For sewer design purposes, workers entering the downtown area of the city from residential sections of the city are considered as part of the residential population where they live and as part of the worker population where they work. Therefore, in the course of a normal week, a worker in this situation is assumed to contribute to the sewage flow in both his home area and in his office building, store, or other place of employment. In our estimates, we consider that workers making up this segment of the total contributing population remain in their area of employment generally between the hours of 8 AM and 5 PM, or for a period of nine hours on each normal working day.

Transient Population

The transient population has been defined as those persons who visit the downtown area for business, recreation, or other purposes for some portion of the day. During the 1964 Cordon Count of downtown Boston described above, approximately 600,000 persons were counted crossing the Cordon line by all means of transportation between the hours of 9 AM and 4 PM. Based on the 1964 study, we estimate that, at present, about half this number or approximately 300,000 persons enter the city each day as visitors or shoppers, composing the transient population as shown on Table 5. Numbers of transients no doubt enter the city before 9 AM and leave the city after 4 PM, and some workers enter between these hours. Based on these considerations, 300,000 appears to represent a reasonable estimate of the number of transients in the city during an average weekday. By increasing this figure in proportion to the 1963-1975 increase in total persons entering the core area as estimated by the Boston Redevelopment Authority, we estimate that the total number of transients in the downtown area of the city during an average weekday may in the year 2020 be about 450,000.

Based upon retail sales data in the downtown area furnished by the Chamber of Commerce, the Federal Reserve Bank of Boston, and the Retail Trade Board, we estimate that, during periods of maximum day may be about 500,000 in 1967 and 750,000 in 2020, as shown on Table 5 . Based on an area of 800 acres estimated to be in commercial use in the year 2020, we have used a design density of 950 persons per acre for the transient segment of the population in the downtown area of the city.

Sanitary Sewage Flow

Average rates of sanitary sewage flow for a city such as Boston may be most readily determined for measurements of water consumption. Practically all water consumed in Boston is supplied by the MDC and is fully metered before entering the City of Boston water distribution system.

Fig. 10 shows the estimated relationship between the quantity of water supplied by the MDC to the City of Boston water distribution system and the quantity of sanitary sewage reaching the Boston sewerage system. This relationship was determined by analysis of city and MDC water records and other information furnished by the city. Based on this analysis, it may be seen that an estimated 80 per cent of the water supplied to the city reaches its sewerage system. We have used this percentage figure in estimating average sanitary sewage flows for design, as discussed hereinafter.

We have conducted a gaging program at two high-rise type apartment buildings located at 6 and 8 Whittier Place in the Charles River Park Apartments complex. The purpose of this program was to determine the correlation between water consumption and sewage discharge during a normal weekday for this type of residential area. The results of the gaging program are presented on Figs. 11 and 12, and a graphical generalization of these results is shown on Fig. 13. Mechanical difficulties with the gages prevented the obtaining of data for water consumption and sewage discharge for the same day.

It may be seen that, in general, the shapes of the two curves on Fig. 13 are quite similar, with peaks occurring at about the same time. The average daily sewage flow for the two buildings is close to the average daily water consumption after air conditioning losses and extraneous flows have been deducted. Therefore, we have considered it reasonable to use water consumption records as bases of sewage flow estimates for apartment buildings, as shown on Table 3. In addition, data on four of the buildings shown on Table 3 have been plotted on Fig. 8 as a check on the Group H curve.

Average daily water consumption is defined as the total consumption for a year, divided by the number of days in that year. The average per capita consumption is equal to the average daily water consumption divided by the population served. Fig. 14 shows the average per capita water consumption for the City of Boston since 1950 as metered by the MDC, together with a projection of the average per capita sewage flow trend for the city to the year 2020.

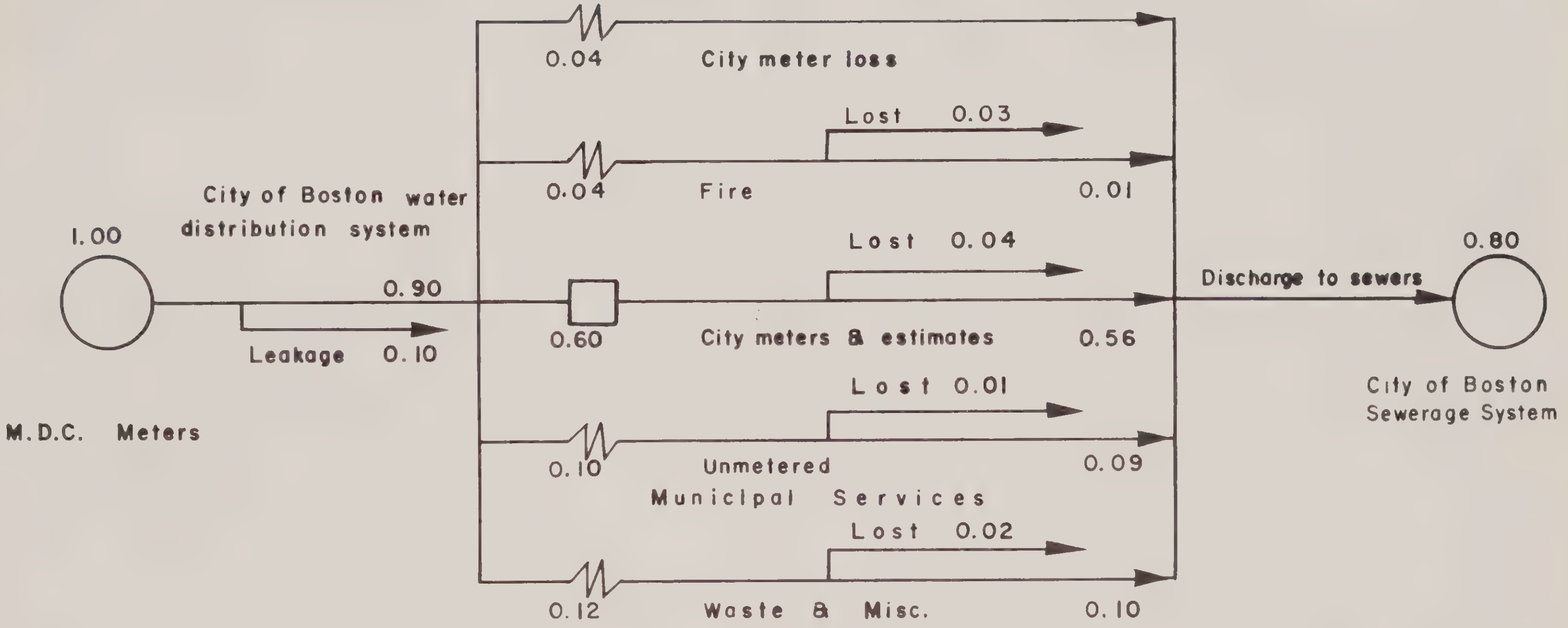

FIG. 10 DIAGRAM SHOWING WATER CONSUMPTION & DISCHARGE INTO SEWERAGE SYSTEM

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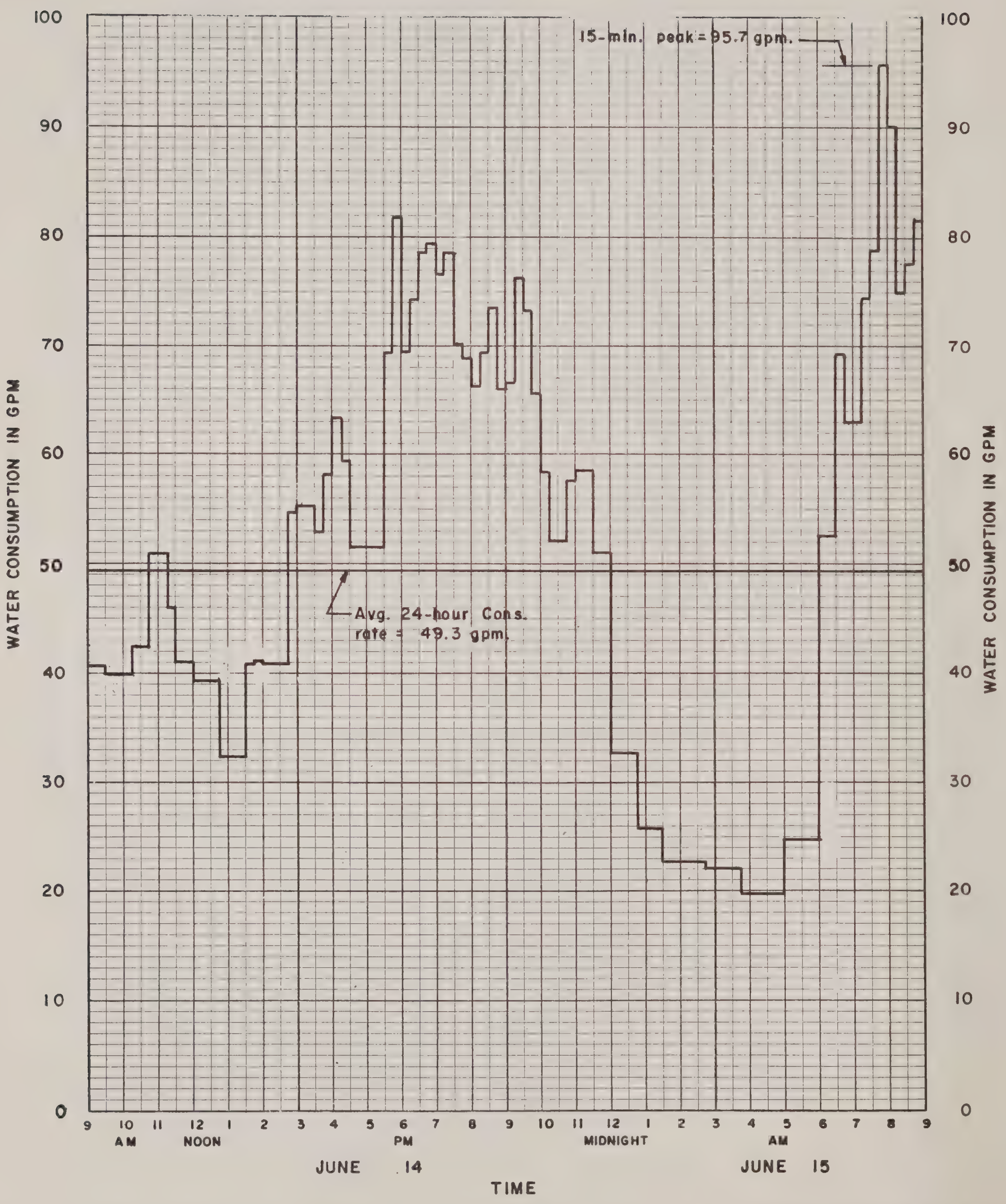

FIG. 11 FLUCTUATIONS IN WATER CONSUMPTION AT 6 & 8 WHITTIER PLACE IN CHARLES RIVER PARK APARTMENT COMPLEX ON JUNE 14-15, 1966

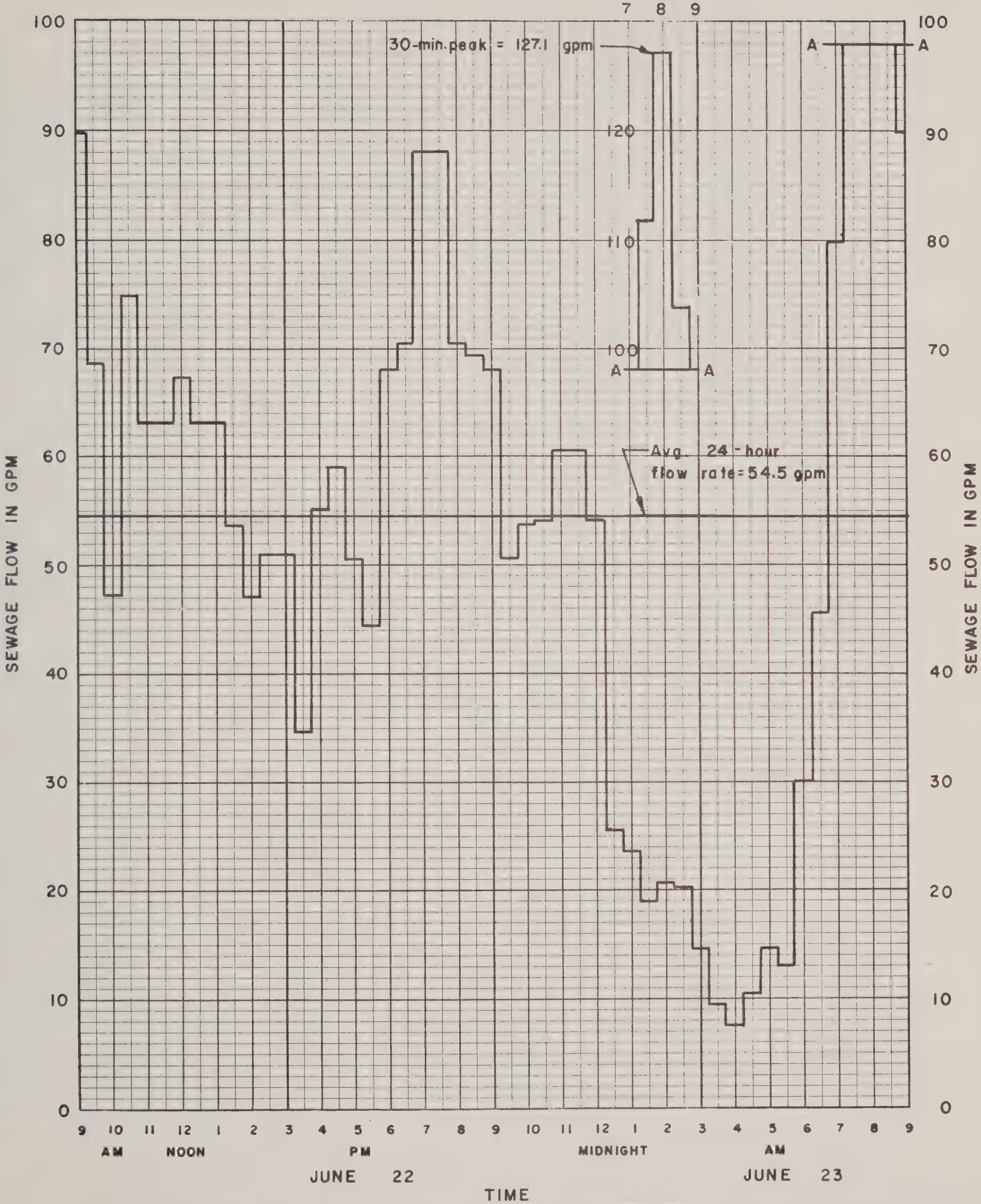

FIG. 12 FLUCTUATIONS IN SEWAGE FLOW AT 6 & 8 WHITTIER PLACE IN CHARLES RIVER PARK APARTMENT COMPLEX ON JUNE 22-23, 1966

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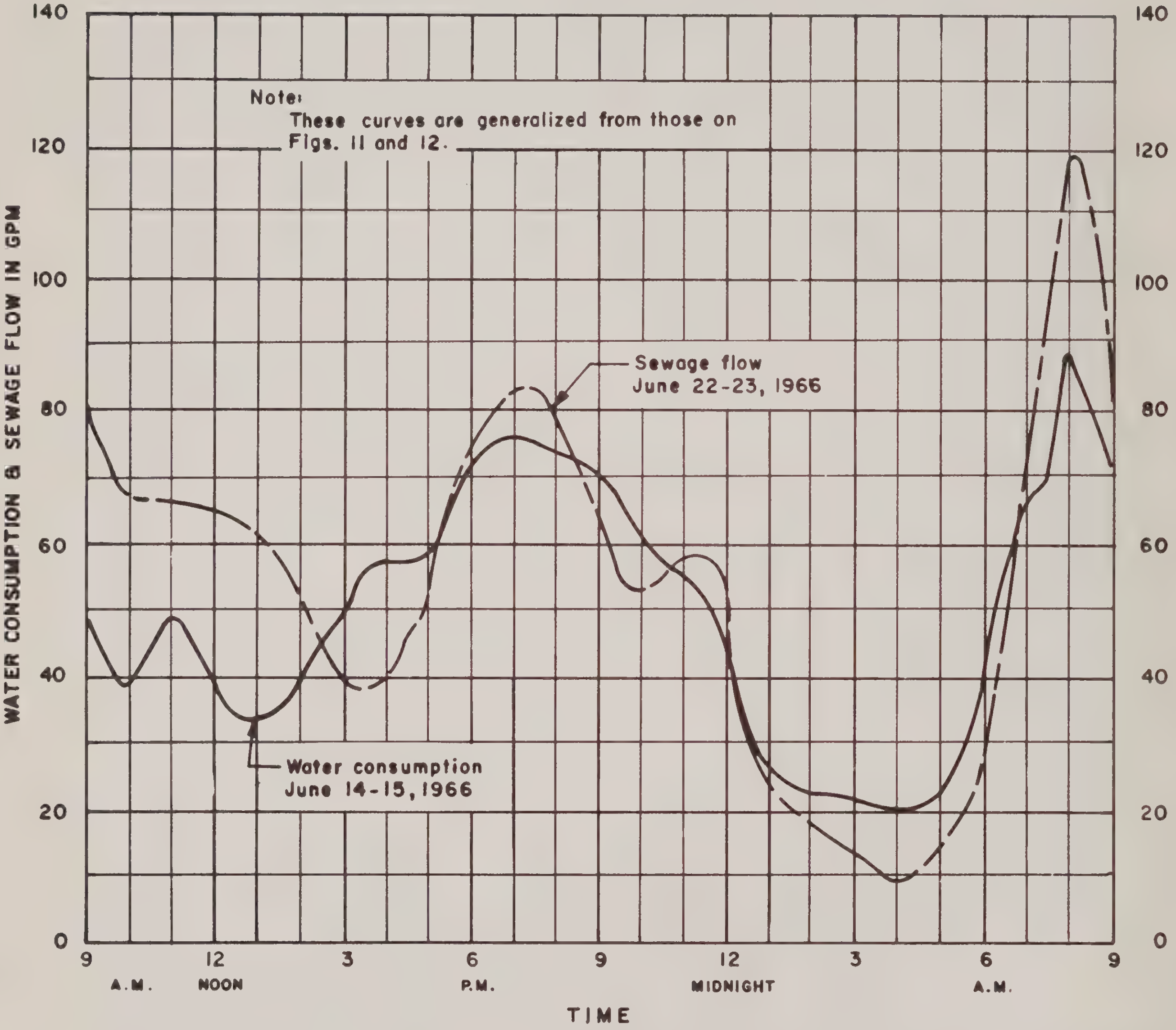

FIG. 13 COMPARISON OF WATER CONSUMPTION & SEWAGE FLOW AT 6 & 8 WHITTIER PLACE IN CHARLES RIVER PARK APARTMENT COMPLEX

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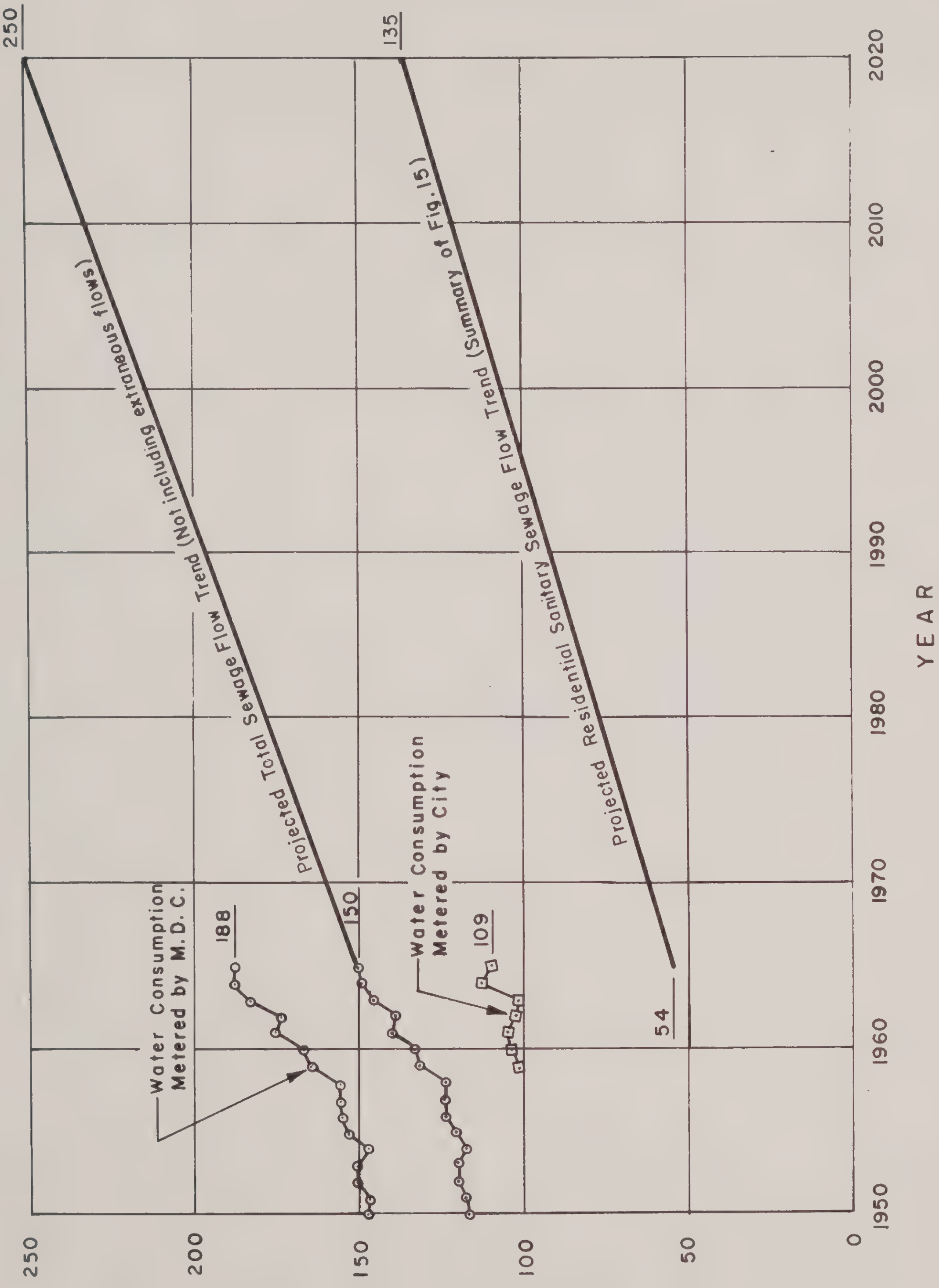


FIG.14 AVERAGE DAILY WATER CONSUMPTION & SEWAGE FLOW TRENDS FOR BOSTON, MASS.

Based on total per capita sewage flow equal to 80 per cent of the water consumption metered by MDC during the period 1960 to 1965, the average per capita sewage flow has increased at a rate of about 2.2 gpcd per year. We have projected the total sewage flow trend for the city to the year 2020 at the average rate of about 1.8 gpcd per year, resulting in an average per capita sewage flow for that year of 250 gpcd. This slightly lower rate of increase (1.8 vs. 2.2) is, in our opinion, justified because while an increasing number of water-using appliances are expected to be used by the general public, there should be an increasing tendency toward the use of devices more economical in their usage of water.

The flows considered to be included in the "Projected Total Sewage Flow Trend" for the city, shown on Fig. 14, are from industries and from resident, worker and transient populations of the city. Estimates of sanitary sewage flow, which includes the flows from the three population segments, have been developed as described hereinafter.

Residential Sanitary Sewage Flow. Estimates of residential sanitary sewage flow were made based upon detailed analyses of 1965 water consumption records for ten residential water services in each ward of the city. Flow estimates were then grouped according to zoning districts within each ward.

Table 7 shows the basis of estimates of average daily per capita sanitary sewage flow for each residential population density group, based on the zoning district studied. The weighted average sewage flow figures shown have been used in the design of sewers for residential population density groups shown. We estimate that the average daily per capita sanitary sewage flow for the city as a whole was 54 gpcd in 1965. We have estimated that, in low density residential areas, approximately 90 per cent of the water consumption recorded by the city becomes sanitary sewage flow, in moderate density residential areas 95 per cent becomes sanitary sewage flow, and in other areas of the city, practically all of the recorded water consumption becomes sanitary sewage flow.

The sanitary sewage flow for each residential population density group was projected, as shown on Fig. 15, to the year 2020. Flow for Group LA was projected at a rate of approximately 1.0 gpcd per year; Group LB at a rate of 2.0 gpcd per year; Group M at a rate of about 1.5 gpcd per year, and Group H at a rate of about 2.0 gpcd per year. The estimated average daily residential sewage flow fro the year 2020, as shown on Fig.14, is 130 gpcd. An important determinant in projecting these average sanitary sewage flow rates in the probability that improvement of living conditions in high density residential and industrial or commercially zoned areas will result in greater than average increases in per capita sanitary sewage flow rates in these areas.

Worker Sanitary Sewage Flow. Estimates of sanitary sewage flow from workers in the downtown commercial area were based upon the data presented in Table 6. From these data, we estimate that the average weekday per capita sewage flow was equal to about 45 gpcd for a recent full year of water records (1964, 1965 or 1966).

All buildings contacted have air conditioning facilities with cooling towers. We estimate that all water consumed in these buildings with the exception of losses from evaporative-type air conditioners reaches the sewers. The quantity of make-up water required for the operation of the

TABLE 7 ESTIMATED AVERAGE DAILY PER CAPITA RESIDENTIAL SANITARY SEWAGE FLOW, CITY OF BOSTON, MASSACHUSETTS

Residential Population Density Group	Zoning District Studied		1965 Estimated Average Daily Sanitary Sewage Flow, gpcd
Group LA (Low Density)	S.3		80.7
	S.5		45.3
	R.5		45.5
		Weighted Average	46.0
Group LB (Low Density)	L-1		45.5
	B-1		42.9
	B-2		23.7
	B-4		26.4
	M-1		36.7
	M-2		48.2
		Weighted Average	39.0
Group M (Moderate Density)	R.8		51.0
	H-1		45.7
		Weighted Average	49.0
Group H (High Density)	H-2		76.1
	H-2 - 65		110.8
	H-3		47.1
	H-5		55.2
		Weighted Average	90.0
		Average for Entire City	54.0

Note: Weighted average sewage flow figures apply to zoning districts grouped within each residential population density group as shown in Table 4 .

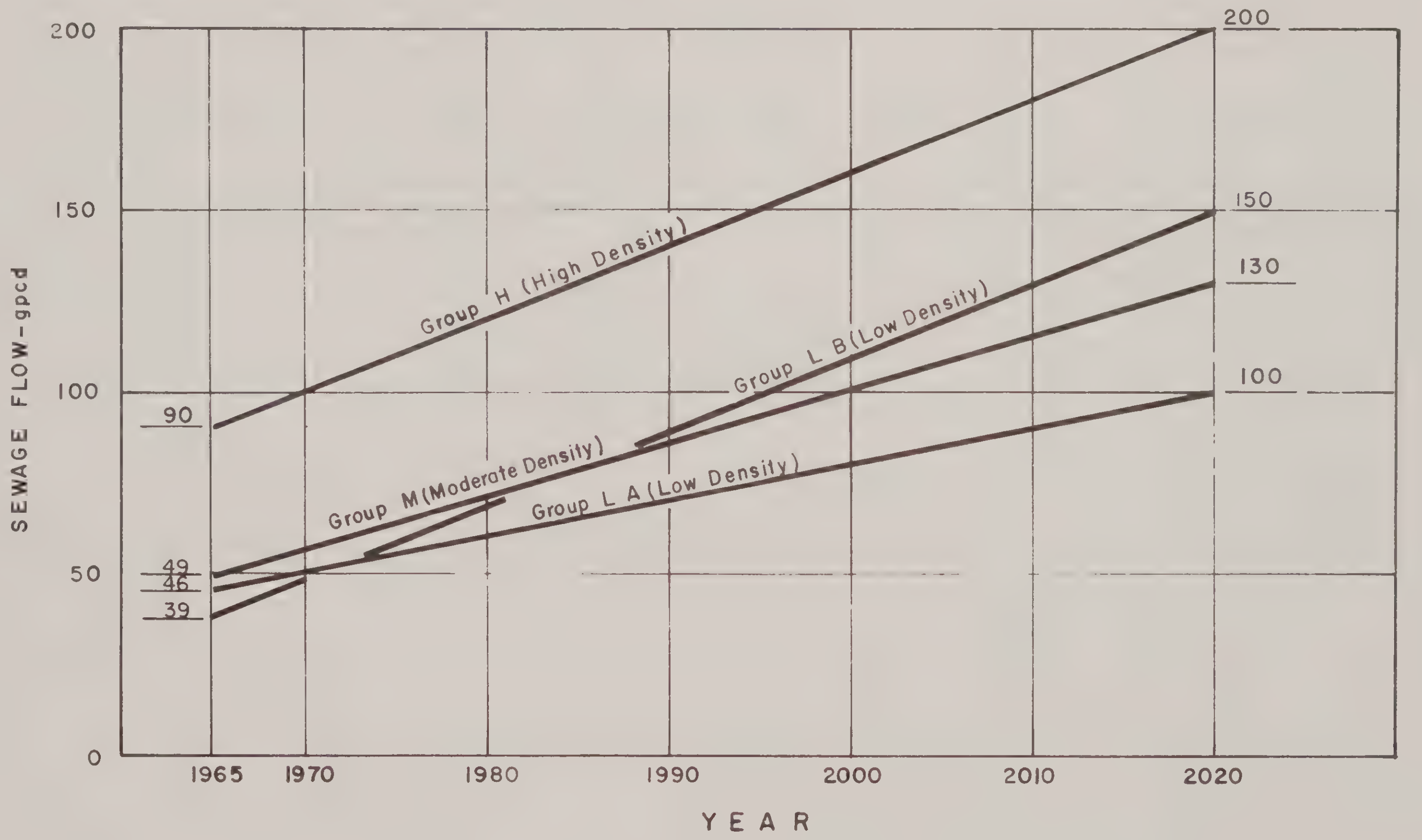


FIG.15 ESTIMATED AVERAGE DAILY RESIDENTIAL SEWAGE FLOW BY GROUPS

257-8382

cooling towers is not metered separately from water used for other purposes. However, estimates of air conditioning water losses have been made, based upon the difference between winter quarter water readings and the average of the readings for the remaining three quarters. These losses for the buildings shown on Table 6 average approximately 18 per cent of the total metered water consumption for the buildings.

Metered water consumption for each building is shown in column 2 of Table 6. Some buildings contacted have restaurants which serve all, or nearly all, of the occupants of the respective buildings, whereas others do not have such facilities. In the case of the Blue Cros-Blue Shield Building, the restaurant is open on weekdays from 12 noon to 2 PM, and served about 850 people in six 20-minute shifts. Dishwashing is done on the premises in all cases where there are restaurants.

Most of the buildings are heated from boilers or furnaces located within the buildings themselves. Water supplied to these heating systems is not metered separately. However, a few of the buildings are heated by steam purchased from the Boston Edison Company, the condensate from which is discharged to the Boston sewerage system.

In order to estimate the average per capita sewage flow for workers in the commercial area in the year 2020, we have used an increase of flow equal to 15 gpcd during the design period. This low rate of increase takes into account greater efforts expected in the future to curb increasing water usage. For the hydraulic design of proposed new sewers to serve until the design year of 2020, we have therefore used a worker average daily per capita sewage flow of 60 gpcd.

Transient Sanitary Sewage Flow. In order to estimate the sanitary sewage flow contributed by the transient (visitor and shopper) segment of the population, we have utilized the 1964 Cordon Count study to determine the approximate length of time spent by the average transient within the downtown area of the city. Based on our analysis of the data in this study, we have determined that, on the average, the transient spends approximately 1.1 hours within the downtown area of the city on a normal weekday. This is approximately 12 per cent of the time normally spent by workers in the downtown area of the city. If we assume that the sewage contributed by the transient segment of the population is directly proportional to the length of time spent within the area by the respective segments of the population, then the average per capita sewage flow for transients is estimated to be approximately 3.2 gpcd for the year 1967 and 6.0 gpcd for the year 2020.

Industrial Waste Flow

To estimate required capacities of sewers and related hydraulic structures, it is necessary to distinguish the waste water flows discharged by major water-consuming industries from flows of sewage discharged by residential and commercial areas and light manufacturing industries, as shown in Table 4. The selection of the larger industries contributing significant amounts of waste water to the city sewers was based on 1965 sewer bills on file in the office of the Public Works Department Sewer Division. In general, industries charged for the discharge of at least 800,000 cubic feet of water per year were considered. Of the over 100 industries selected for further investigation, forty-one were contacted as representative of the various types of industry located in the city.

Thirty-two of the industries contacted furnished sufficient data for the development of design criteria used for this study. A summary of the data obtained and estimated average waste water flows is presented in Table 8 . The average daily flow to the sewer was determined by dividing the total yearly water consumption by the number of working days in that year and multiplying by the per cent of water reaching the sewers as estimated by the company representatives. These estimated waste water flows include both process waste water and sanitary sewage from employees.

Average daily waste water flow per acre for each industry contacted has been plotted against the area of each plant site, as shown on Fig. 16. As shown on Fig. 16, we have chosen for design an average daily waste water flow which varies for industrial areas less than 5 acres, and for industrial areas greater than 5 acres we have chosen a figure of 14,000 gpcd (gallons per acre per day).

Based on land use acreage changes proposed by the Boston Redevelopment Authority for the period 1960 to 1975, we have estimated land use acreages devoted to industrial use through the year 2020. For 1967, we estimate that approximately 4,000 acres are in industrial use throughout the city, and that by 2020 this figure will have increased to about 5,250 acres. Estimates of average daily waste water flow from industrial areas have been based on these acreages.

Extraneous Flow

In designing new sewers, and in computing the total sewage flow to be expected from areas already sewered, allowances must be made for the entrance of extraneous flows. As defined above, extraneous flow is that portion of the total sewage flow resulting from the entrance of ground water, storm water and tide water into a sanitary sewer or dry weather intercepting sewer.

Ground Water. Entrance of ground water into sewers, referred to herein as infiltration, takes place through cracked or broken pipes, defective joints, and leaking manholes. The rate of infiltration varies with the type and tightness of construction, the age of sewer, the ground water elevation, and the permeability of the surrounding soil. For most sewers, it varies somewhat from season to season as the ground water table rises and falls, and is influenced by freezing of the moisture in the soil. It is normally lowest at the end of a prolonged dry period in the summer or during a deep freeze in the winter. However, for sewers located within the tide range, such variations may be nonexistent, and the rate of infiltration may be quite high throughout the year.

Poorly laid building connection lines frequently are important sources of excessive infiltration. Infiltration into such connections has been measured elsewhere and found to be as much as 90 per cent of the total infiltration into a sewerage system.

TABLE 8 WASTE WATER FLOW FROM INDUSTRIES

	Name and Address of Industry (1)	Nature of Industry (2)	Area of Plant Site (acres) (3)	Estimated Average Daily Water Consumption (mgd) (4)	Estimated Portion of Water Consumption to Sewers (%) (5)	Estimated Average Daily Waste Water Flow		Remarks (8)
						(mgd) (6)	(gpad) (7)	
1.	Thompson Wire Co. 39 & 55 Mildred St.	Cold rolled strip steel	1.83	0.076	100	0.076	41,500	High process water use
2.	Allis-Chalmers Mfg. Co. 1344 Hyde Park Ave.	Circuit breakers	13.0	0.051	90	0.046	3,500	90-95% sanitary
3.	Boston Insulated Wire Co. 65 Bay St.	Insulated wire & cable	9.6	0.045	100	0.045	4,700	Mostly cooling
4.	Honeywell, Inc. 1400 Soldiers Field Rd.	Electronic research & development	1.17	0.045	100	0.045	38,500	50% cool, 50% san. Cooling water steady
5.	Westinghouse Elec. Corp. Damon St.	Large fans, heat trans. equipment	21.9	0.110	75	0.082	3,800	Some cooling water
6.	Boston Globe 135 Morrissey Blvd.	Newspaper publishing	7.7	0.134	100	0.134	17,400	Mostly sanitary
7.	Kinney Mfg. Div. 3529 Washington St.	Vacuum pumps	4.4	0.065	100	0.065	14,700	Mostly Cooling
8.	N.E. Provision Co. 960 Mass. Ave.	Meat products	4.1	0.235	80	0.188	46,000	Product cooling, mainly cleanup
9.	Columbia Packing Co. 155 Southampton St.	Meat products	1.38	0.195	80	0.155	117,000	Product cooling and cleanup

TABLE 8 WASTE WATER FLOW FROM INDUSTRIES (Continued)

Name and Address of Industry (1)	Nature of Industry (2)	Area of Plant Site (acres) (3)	Estimated Average Daily Water Consumption (mgd) (4)	Estimated Portion of Water Consumption to Sewers (%) (5)	Estimated Average Daily Waste Water Flow		Remarks (8)
					(mgd) (6)	(gpad) (7)	
10. Miller & Hollis 549 Albany St.	Candy	0.34	0.082	100	0.082	240,000	Mainly cooling
11. Assoc. Laundries, Inc. 21 Clapp St.	Linen supply	0.32	0.041	80	0.033	106,000	Mostly wash water
12. Minn.-Honeywell 38 Life St.	Electronic Assembly	5.7	0.326	100	0.326	57,000	Mostly process water
13. Magnesium Casting Co. 98 Business St.	Die castings	2.5	0.050	95	0.048	19,200	Mostly plating wastes
14. Brockway Glass Plastics 1671 Hyde Park Ave.	Plastic containers	2.84	0.034	100	0.034	12,000	Mostly cooling water
15. General Alloys 405 W. 1st St.	Alloy castings & fabrication	1.16	0.052	100	0.052	45,000	Mostly process water
16. Hearst Corp. 5 Winthrop Square	Newspaper publishing	0.14	0.027	100	0.027	193,000	Mostly sanitary
17. Gillette Safety Razor Co. Gillette Park	Blades & shaving cream	26.0	1.61	65	1.05	40,000	Mostly process water
18. Armour & Co. 775 Columbus Ave.	Meat products	11.5	0.084	100	0.084	7,300	Product cooling and cleanup

TABLE 8 WASTE WATER FLOW FROM INDUSTRIES
(Continued)

Name and Address of Industry (1)	Nature of Industry (2)	Area of Plant Site (acres) (3)	Estimated Average Daily Water Consumption (mgd) (4)	Estimated Portion of Water Consumption to Sewers (%) (5)	Estimated Average Daily Waste Water Flow		Remarks (8)
					(mgd) (6)	(gpad) (7)	
19. James F. Morse & Co. 66 Norfolk Ave.	Tallow and grease	1.31	0.048	100	0.048	36,500	Process water
20. Broadway Poultry 412 Dorchester Ave.	Poultry processing	0.38	0.026	100	0.026	68,300	Product cooling and cleanup
21. Herald Traveler 300 Harrison Ave.	Newspaper publishing	6.15	0.053	100	0.053	8,600	Mostly cooling and washing
22. Hub Laundry 32 Bristol St.	Laundry	0.22	0.089	100	0.089	405,000	Mostly wash water
23. Morrison & Schiff 35 Hichborn	Delicatessen meats	0.36	0.052	60	0.032	89,000	Mostly cooling and cleanup
24. Morgan Laundry Service 939 Mass. Ave.	Laundry	0.65	0.168	75	0.127	195,000	Mostly wash water
25. Brighams, Inc. 33 Everett St.	Bakery products	1.49	0.031	50	0.015	10,000	Sanitary and cleanup
26. Albany Carpet Cleaning 18-32 Penniman	Rug cleaners	1.54	0.068	100	0.068	44,000	Mostly rinse water
27. WGBH (Channel 2) 125 Western Avenue	Television Studios	2.15	0.038	100	0.038	17,700	Mostly cooling

TABLE 8 WASTE WATER FLOW FROM INDUSTRIES
(Continued)

Name and Address of Industry (1)	Nature of Industry (2)	Area of Plant Site (acres) (3)	Estimated Average Daily Water Consumption (mgd) (4)	Estimated Portion of Water Consumption to Sewers (%) (5)	Estimated Average Daily Waste Water Flow		Remarks (8)
					(mgd) (6)	(gpad) (7)	
28. S.S. Pierce 133 Brookline Ave.	Bottled spirits Bakery products	2.63	0.083	40	0.033	10,500	Mostly sanitary
29. Union Paste Co. 1605 Hyde Park Ave.	Industrial adhesives	3.00	0.024	90	0.022	7,300	Mostly cooling
30. Cole-Hersee Co. 18 Old Colony Ave.	Automotive Electric Equipment	2.3	0.034	100	0.034	15,000	Mostly sanitary
31. Coca-Cola 400 Soldiers Field Road	Soft Drink Bottling	2.58	0.115	85	0.097	37,600	Mostly wash water
32. Keystone Camera Co., Inc. 151 Hallet St.	Movie projectors	6.7	0.307	10	0.031	4,600	Mostly sanitary

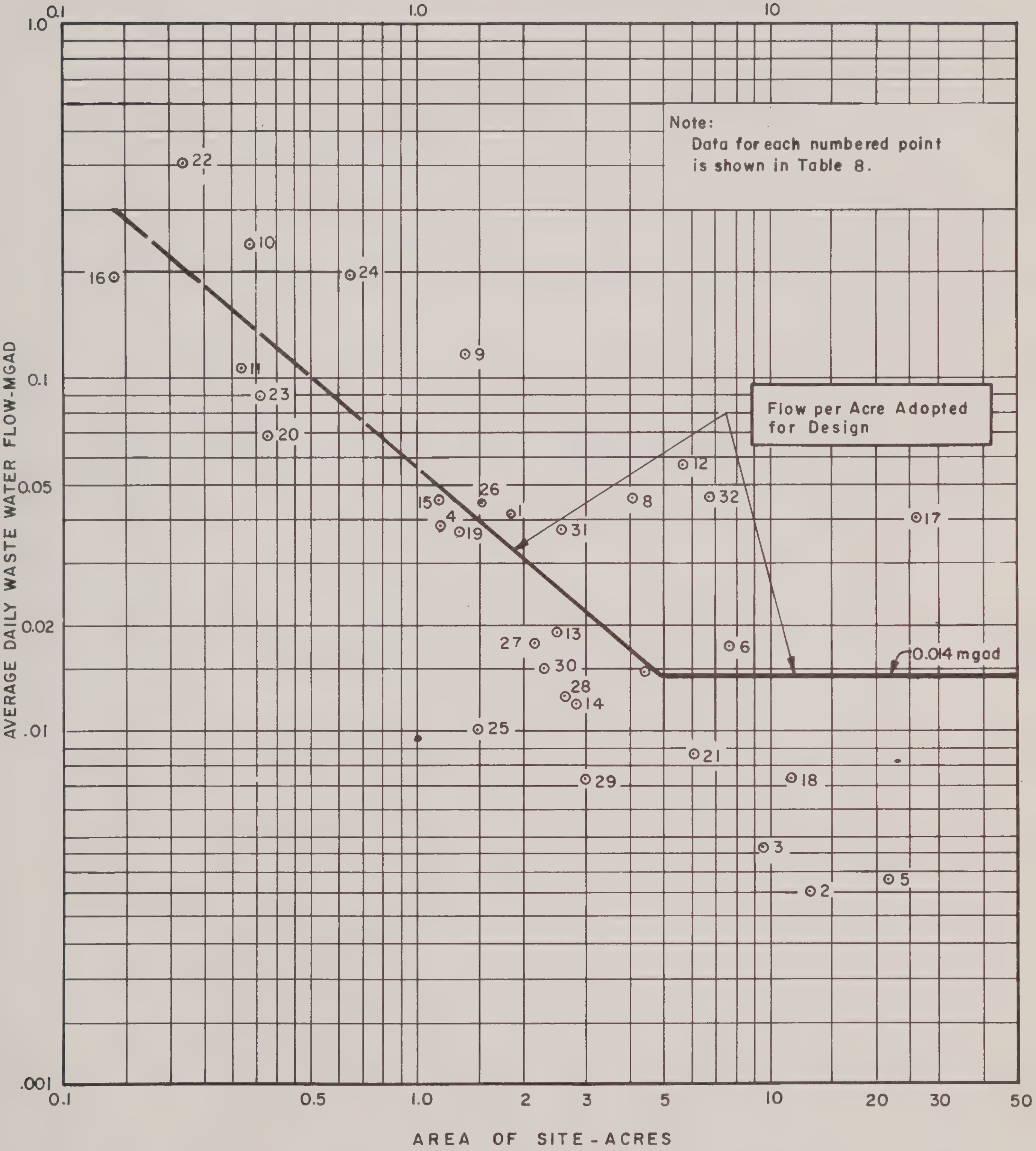


FIG. 16 WASTE WATER FLOW FROM INDUSTRIAL AREAS

Sewer gagings were conducted at 25 points throughout the City of Boston sewerage system for this study. They provide a measure of sewage flow rates from areas tributary to these points under the conditions existing during the gaging period. The total area tributary to the gaging points is about 1,325 acres, or 6.5 per cent of the estimated presently sewered area of the city. The gagings were conducted during the months of June, July and August, 1966.

Many of the sewers gaged are combined sewers, containing sewage, storm water during stormy periods and, in some cases, tide water. Weather during the period of gaging was quite dry, and corrections were made for those few occations when storm water was present. For those gaging points affected by tides, measurements were scheduled to obtain minimum flows during periods of low tide. Consequently, we assumed that the minimum daily flows recorded, after necessary corrections for storm runoff, were made up entirely of minimum daily dry weather discharge and ground water infiltration.

The infiltration occurring on each day of gaging was assumed to be 80 per cent of the minimum flow recorded on that day in residential areas and 90 per cent in commercial areas with low night-time population.

Ground water infiltration may be expressed in gpad (gallons per acre per day) or gpmd (gallons per mile of sewer per day). For the purposes of this study, the area relationship (gpad) has been used to facilitate estimates because of the size and complexity of the Boston sewerage system.

The results of our gagings to determine infiltration rates in existing sewers are presented on Table 9. Based on the above considerations, these gagings show that infiltration rates during the gaging period varied from 4,300 to 58,000 gpad, with an average of about 17,500 gpad for combined sewers, and varied from 50 to 17,300 gpad with an average of about 1,500 gpad for separate sanitary sewers. Combined sewers are most frequently located in areas of high ground water or subject to tidal effects, and therefore we have used 17,500 gpad as the average rate of infiltration for such sewers. On the other hand, for separate sewers, most having been constructed more recently than combined sewers and in areas of relatively low ground water not subject to tidal effects, we estimate 1,500 gpad as the minimum rate of infiltration.

We have adopted for the design of proposed sanitary sewers and dry weather intercepting sewers infiltration rates for existing sewers as shown in the following table.

INFILTRATION RATES FOR AREAS SERVED BY EXISTING SEWERS

	Combined	Separate Sanitary
Minimum, gpad	10,000	1,500
Average, gpad	17,500	2,500
Maximum, gpad	25,000	4,000

TABLE 9. INFILTRATION RATES IN EXISTING SEWERS

Sewer Gaging Point No. (1)	Location (2)	Tributary Sewered Area (acres) (3)	Measured Minimum Flow Rate (gpd) (4)	Estimated Infiltration Rate (gpd) (5)	Estimated Infiltration Rate (gpad) (6)	Type of Sewer Gaged (7)
1	South Boston - East 3rd St. between "K" St. and "L" St.	30.3	771,000	616,000	20,400	Combined
2	South Boston - "K" St. at East 7th St.	24.4	131,900	105,500	4,330	Combined
3	South Boston - Flaherty Way	17.6	1,041,000	833,000	47,400	Combined
4	Roxbury - Blue Hill Ave. at Huckins St.	44.4	337,000	270,000	6,080	Combined
5	Roxbury - Forbes St.	18.9	132,500	106,000	5,610	Combined
6	Roxbury - Pilgrim St.	8.9	192,600	153,800	17,290	Separate Sanitary
7	Downtown - Federal St.	15.3	987,000	889,000	58,100	Combined
8	North End - Hanover St.	6.1	380,000	304,000	49,900	Combined
9	West Roxbury - Centre St.	190.0	118,400	94,800	500	Separate Sanitary
10	Brighton - Parsons St. at Barker St.	46.1	66,200	53,000	1,150	Separate Sanitary

TABLE 9. INFILTRATION RATES IN EXISTING SEWERS
(Continued)

Sewer Gaging Point No. (1)	Location (2)	Tributary Sewered Area (acres) (3)	Measured Minimum Flow Rate (gpd) (4)	Estimated Infiltration Rate (gpd) (5)	Estimated Infiltration Rate (gpad) (6)	Type of Sewer Gaged (7)
11	Brighton - Wallingford Road	20.0	6,350	5,080	250	Separate Sanitary
12	Brighton - Franklin St. at Easton St.	30.3	78,800	63,000	2,080	Separate Sanitary
13	West Roxbury - V.F.W. Parkway at Independence Drive	228.6	105,600	84,500	370	Separate Sanitary
14	West Roxbury - Gardner St.	192.0	202,000	161,700	840	Separate Sanitary
15	Dorchester - Milton Ave. at Armandine St.	16.7	1,031	825	50	Separate Sanitary
16	West Roxbury - Canterbury St. at Pinedale Road	127.0	554,000	444,000	3,500	Separate Sanitary
17	Dorchester - Argyle St. at Argyle Terrace	20.7	174,400	139,500	6,740	Combined
18	Dorchester - Minot St. near Saranac St.	23.7	107,300	85,900	3,620	Separate Sanitary
19	Hyde Park - Cleveland St. at River St.	27.1	216,000	172,900	6,370	Separate Sanitary

TABLE 9. INFILTRATION RATES IN EXISTING SEWERS
(Continued)

Sewer Gaging Point No. (1)	Location (2)	Tributary Sewered Area (acres) (3)	Measured Minimum Flow Rate (gpd) (4)	Estimated Infiltration Rate (gpd) (5)	Estimated Infiltration Rate (gpad) (6)	Type of Sewer Gaged (7)
20	Hyde Park - Easton Ave. at Dana Ave.	116.0	155,000	124,000	1,070	Separate Sanitary
21	Hyde Park - Blake St. near River St.	18.2	11,750	9,400	520	Separate Sanitary
22	Dorchester - Erie St. at Seaver St.	39.6	181,000	144,800	3,660	Separate Sanitary
23	Dorchester - Coleman St.	34.4	344,000	275,000	8,000	Combined
24	East Boston - Faywood St.	17.0	30,000	24,000	1,410	Separate Sanitary
25	East Boston - Bennington St.	13.4	493,000	394,000	29,400	Combined

The maximum infiltration rate shown for existing combined sewers has been used for tributary areas up to approximately 20 acres. For tributary areas between 20 and 250 acres, we have used maximum infiltration rates decreasing from 25,000 gpad to 4,000 gpad and, for areas greater than 250 acres we have used 4,000 gpad. For all existing combined sewers, we have used an infiltration rate of 4,000 gpad.

For new sewers to be constructed in presently unsewered areas, in areas now served by combined sewers, or by separate sanitary sewers requiring replacement, lower infiltration rates may be readily obtained by using modern compression type joints. We have adopted the infiltration rates for areas to be served by new sanitary sewers and dry weather intercepting sewers shown in the following table:

INFILTRATION RATES FOR AREAS TO BE SERVED BY PROPOSED NEW SEWERS

Minimum	1,000 gpad
Average	1,500 gpad
Maximum	2,000 gpad

Storm Water. Proposed control structures and dry weather flow interceptors have been designed such that all flows in excess of interceptor capacities will pass to nearby water bodies. When the proposed Deep Tunnel Plan is constructed, as discussed in Chapter VII and in detail in Appendix F, such overflows will be received by deep rock storage tunnels. Therefore, no allowance has been made for storm water in the design of principal dry weather interceptors.

For roof, areaway and foundation drains and catch basins connected to a sanitary sewer, contributions of storm water are excessive. Regulations should be rigidly enforced to prevent the entrance of storm water into sanitary sewers from all sources. Since full compliance with such regulations may result in increased building construction costs, and in added expense to owners of many existing buildings, it must be anticipated that there will not be full compliance to such enforcement. Furthermore, separation of building plumbing will in many cases be impossible to accomplish as a practical matter as discussed in Chapter VII.

Tide Water. In the lower reaches of the existing Boston sewerage system, the entrance of tide water into sewers is a major source of extraneous flow. This has been true for many years. In Senate Document No. 56, January 1931, it was stated, "The main sewers of the Boston Main Drainage System and those in the low territory in the North Metropolitan District adjacent to salt water have been found to receive in some cases considerable leakage through tide gates at regulated overflows to the harbor or tributary waters." Tide gates were originally installed at points of discharge from the sewerage system into Boston Harbor and its estuaries in order to prevent the entrance of tide water into the sewerage system during high tide levels and permit excess sewage flows to be discharged through regulating structures during sufficiently low tide levels. However, from observations made during the course of this study as well as the reports of previous investigators, it is evident that during incoming tides there is considerable leakage of tide water back into the sewerage system due to broken, inoperative, or blocked tide gates. On outgoing tides, raw sewage is discharged through the tide gates into the harbor each day, regardless of weather conditions. In many of the sewers affected by tide water, the sewers are surcharged above their crowns for extended periods during each tidal cycle, thus greatly reducing the sewer capacities available for storm and sewage flows. Our design estimates of required capacity for proposed new sanitary sewers and dry weather interceptors, as well as our determination of the adequacy of existing sewers, contemplate the exclusion of all tide water from the sewerage system. Therefore, no design allowances for the entrance of tide water have been made.

Estimated Sewage Flows

Average rates of sewage flows, used as bases of design for sanitary sewers and dry weather interceptors, were developed as discussed above. Sanitary sewage flows from residential, worker and transient population segments of the city, industrial waste flow, and extraneous flow have been estimated individually for the design of proposed work and to determine the adequacy of existing sewers.

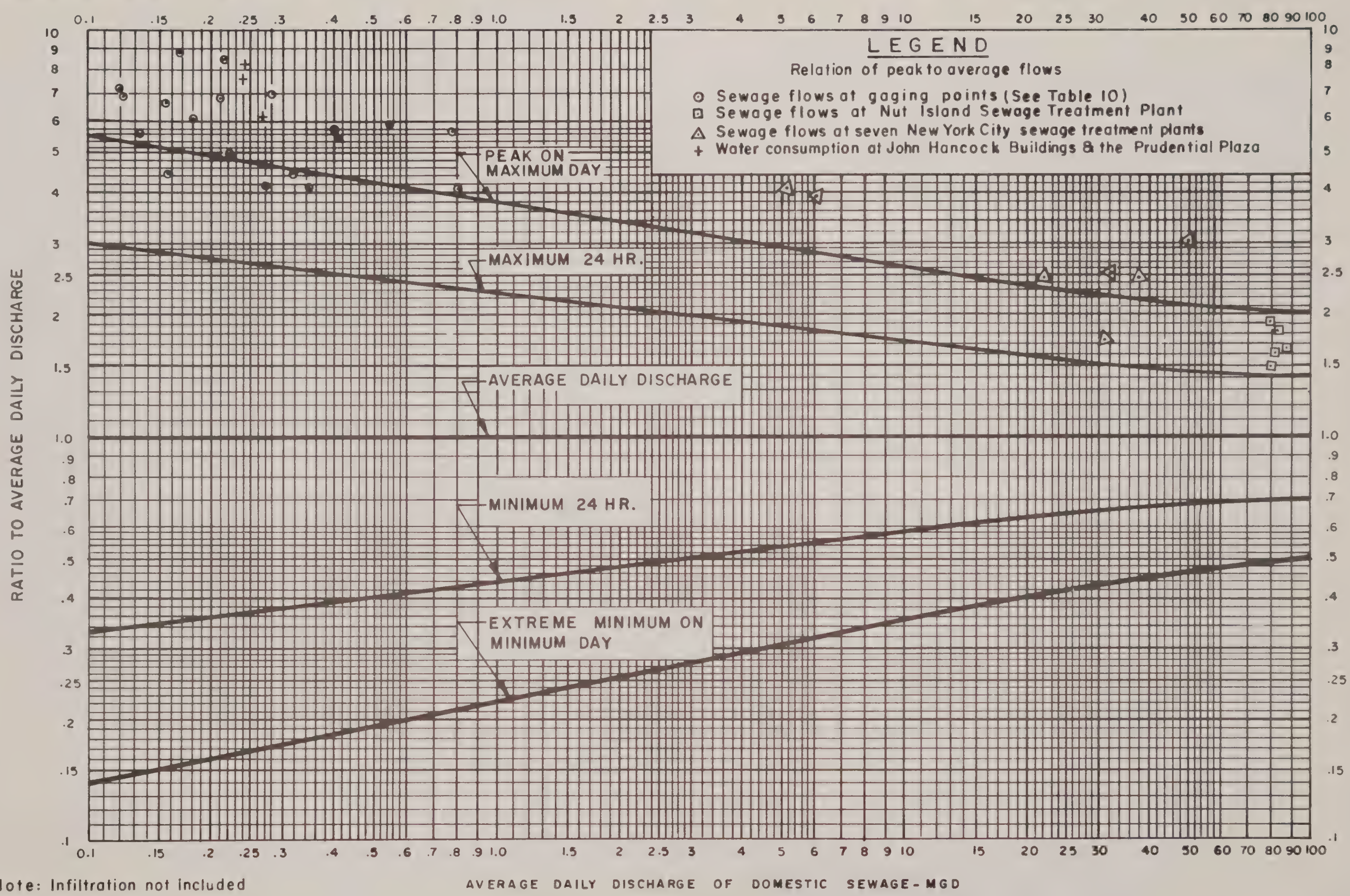
The average daily flow of sanitary sewage in a year is the total flow for the year divided by the number of days in the year. The flow on any one day will be greater or less than this average, and there is one day in each year in which the 24-hour flow is a maximum, and another day in which the 24-hour flow is a minimum. Moreover, the flow fluctuates throughout each 24-hour day, such that there is a peak flow and a minimum flow on each day. As a result, there is a peak rate of flow occurring on the maximum day and an extreme minimum rate of flow occurring on the minimum day.

The design of sanitary sewers is based upon the peak flows expected from tributary areas in the year 2020. For this reason, it has been necessary to determine the relationship between peak flows and average daily flows of sewage. Peak flows of industrial waste water have been determined from average flows, together with sanitary sewage, as discussed below. Maximum rates of extraneous flow have been developed as discussed above.

The relationship of sewage discharges, including industrial waste water flows, on maximum and minimum days to the average daily discharge of sewage for the year is shown on Fig.17. These curves have been developed, used and confirmed by experience in many communities throughout New England. To determine the validity of these curves for the Boston sewerage system, we have conducted an extensive sewer gaging program at 25 points throughout the city, the results of whch are listed in Table 10..

We have also reviewed records of the Nut Island Sewage Treatment Plant, and have determined flow ratios from these records. Data for five points have been plotted on Fig. 17 and indicate the range of ratios obtained. Flow ratios for seven New York City sewage treatment plants have also been plotted.

To determine the ratio of peak sanitary sewage flow to average daily sanitary sewage flow from commercial buildings, we have conducted extensive monitoring of the water consumption in the two John Hancock Buildings which are considered to be fairly representative of the larger commercial buildings in Boston. Such data assisted in establishing the applicability of the curves on Fig. 17 to flows of sanitary sewage in commercial areas. Gaging



Note: Infiltration not included

FIG. 17 RELATION OF EXTREME DISCHARGES ON MAXIMUM AND MINIMUM DAYS TO THE AVERAGE DAILY DISCHARGE OF DOMESTIC SEWAGE

Camp, Dresser & McKee
Consulting Engineers
Boston, Mass.

257-8384

TABLE 10 ESTIMATED SANITARY SEWAGE FLOWS IN EXISTING SEWERS

Point No. (1)	Location (2)	Tributary Area (acres) (3)	Estimated Sanitary Sewage Flows: Minimum Rate (mgd) (4)	Estimated Sanitary Sewage Flows: Average Daily (mgd) (5)	Estimated Sanitary Sewage Flows: Peak Rate (mgd) (6)	Flow Ratios: Peak to Average (7)	Flow Ratios: Minimum to Average (8)
1	E. 3rd Street	30.3	0.154	0.808	1.434	1.78	0.191
2	"K" Street	24.4	0.026	0.409	0.898	2.20	0.065
3	Flaherty Way	17.6	0.208	0.345	0.549	1.59	0.603
4	Blue Hill Avenue	44.4	0.067	0.210	0.520	2.48	0.320
5	Forbes Street	18.9	0.265	0.134	0.261	1.94	0.197
6	Pilgrim Road	8.9	0.004	0.157	0.251	1.60	0.025
7	Federal Street	15.3	0.075	0.776	1.900	2.45	0.097
8	Hanover Street	6.1	0.076	0.546	1.343	2.46	0.139
9	Centre Street	190.0	0.024	0.155	0.364	2.35	0.152
10	Parsons Street	46.1	0.013	0.070	0.224	3.20	0.190
11	Wallingford Road	20.0	0.001	0.024	0.129	5.41	0.053
12	Franklin Street	30.3	0.016	0.120	0.292	2.43	0.131
13	V.F.W. Parkway	228.6	0.021	0.169	0.534	3.17	0.125
14	Gardner Street	192.0	0.040	0.318	0.544	1.71	0.127
15	Milton Avenue	16.7	0.0002	0.009	0.045	4.91	0.022
16	Canterbury Street	127.0	0.111	0.401	0.899	2.24	0.276
17	Argyle Street	20.7	0.035	0.215	0.674	3.13	0.162
18	Minot Street	23.7	0.021	0.180	0.394	2.18	0.119
19	Cleveland Street	27.1	0.043	0.123	0.292	2.38	0.351
20	Easton Avenue	116.0	0.031	0.280	0.740	2.64	0.111
21	Blake Street	54.0	0.002	0.033	0.066	2.02	0.072
22	Erie Street	39.6	0.036	0.121	0.281	2.32	0.300
23	Coleman Street	34.4	0.069	0.222	0.415	1.87	0.310
24	Faywood Street	17.0	0.006	0.042	0.118	2.79	0.142
25	Bennington Street	13.4	0.098	0.270	0.421	1.56	0.364

Notes:
(a) Estimated flows are based on sewer gagings.
(b) Data plotted on Fig.17.

of the sewers serving the John Hancock Buildings was not undertaken because of the extreme complexity of the sewerage system in that area. The fluctuations in water consumption on May 19, 1966 for the John Hancock Buildings are shown on Figs. 18 and 19. In addition, we have determined peak and average rates of water consumption at the Prudential Plaza, based on data obtained by Charles A. Maguire and Associates on June 14 and 15, 1966. The fluctuations in rates of water consumption at the Prudential Plaza are shown on Fig. 20 . We have assumed that fluctuations in the flow of sanitary sewage for these buildings are similar to those for water consumption.

The results of the above investigations were sufficient, in our opinion, to warrant the use of the curves shown on Fig. 17 in determining required capacities of sewers and appurtenant facilities. Estimated peak and minimum flows of sanitary sewage have been based on the relationship established on Fig. 17.

Table 11 shows the estimated sewage flows for the entire city for the years 1967, 1995 and 2020. The flows presented in this table are those which may be expected to enter the sewerage system during the dry weather period. If sufficient interceptor capacities are provided, and facilities are constructed for discharging excessive storm flows and preventing the entrance of tide water, we estimate that the flows shown in Table 11 will reach the existing MDC headworks, tunnels and disposal facilities. We further estimate that approximately 75 per cent of the average daily dry weather sewage flow under these conditions reaches the Deer Island Sewage Treatment Plant in 1967 and 25 per cent reaches the Nut Island Sewage Treatment Plant.

Storm Conduits

General

Principal existing storm conduits and combined sewers have been analyzed to determine whether their capacities are sufficient to carry the estimated future 15 year frequency design storm flows without excessive surcharging. Excessive surcharging has been taken to mean a condition under which the hydraulic grade line approaches to within about two feet of ground surface at critical locations during the design storm.

Proposed conduits which are to carry storm water runoff from their tributary areas, whether or not mixed with some sewage, have been designed to flow full without surcharging at invert slopes sufficient to provide a minimum flowing full velocity of 3 feet per second.

Existing storm conduits which discharge to tide water or to the Charles River Basin and conduits proposed to do so, have been considered to discharge at outlet water surface of Elev. 13.0 (Boston City Base). "Critical tide levels" are discussed in Chapter II. Combined sewer outlets are discussed hereinbefore.

Runoff Estimates

The peak rate of storm water runoff for which each section of a drainage system was analyzed or designed, was estimated by the means of the so-called "rational method", using the zone principle for rectangular areas.

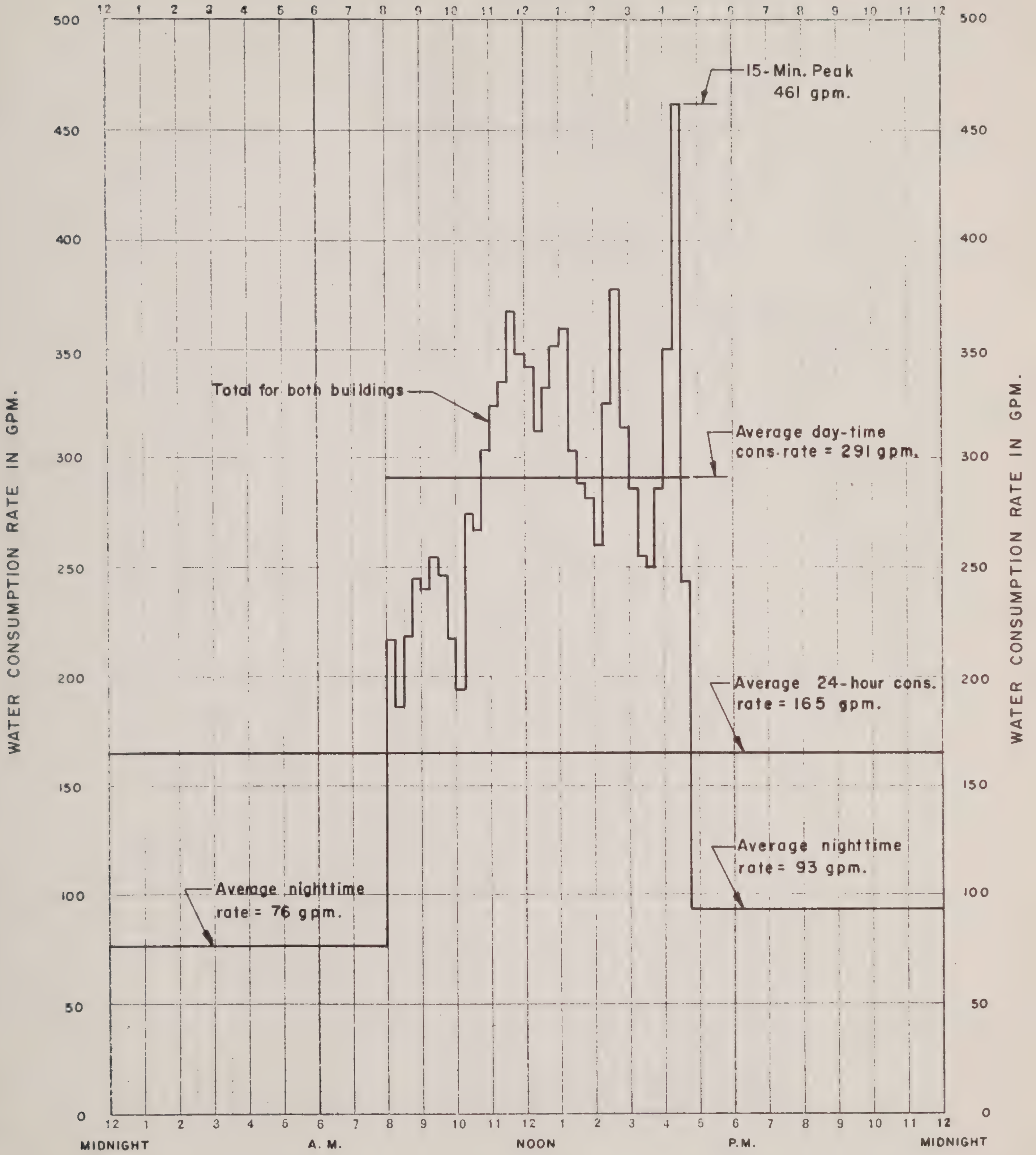


FIG. 18 FLUCTUATIONS IN WATER CONSUMPTION AT JOHN HANCOCK BUILDINGS ON MAY 18, 1966

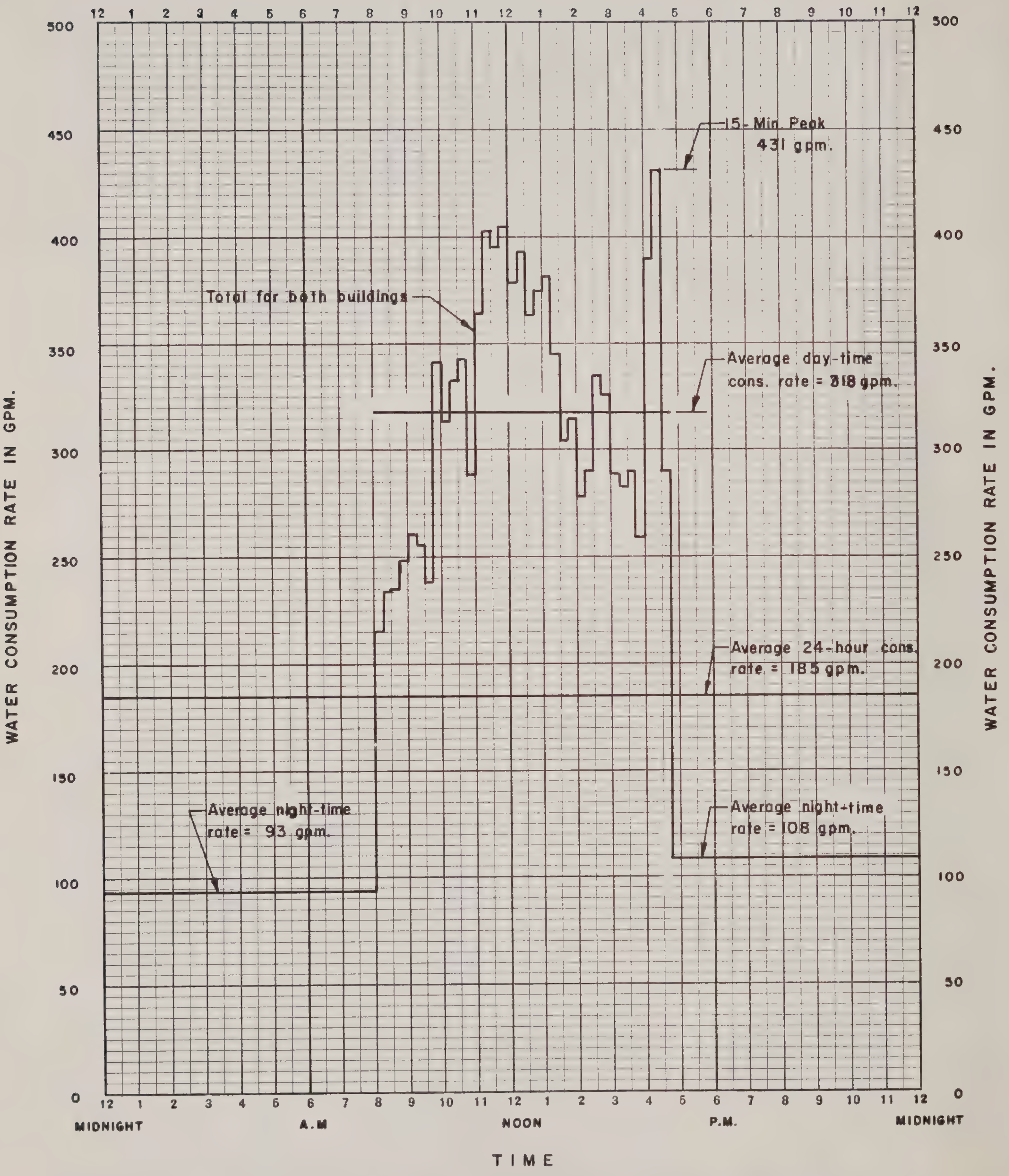


FIG. 19 FLUCTUATIONS IN WATER CONSUMPTION AT JOHN HANCOCK BUILDINGS ON MAY 19, 1966

257-8386

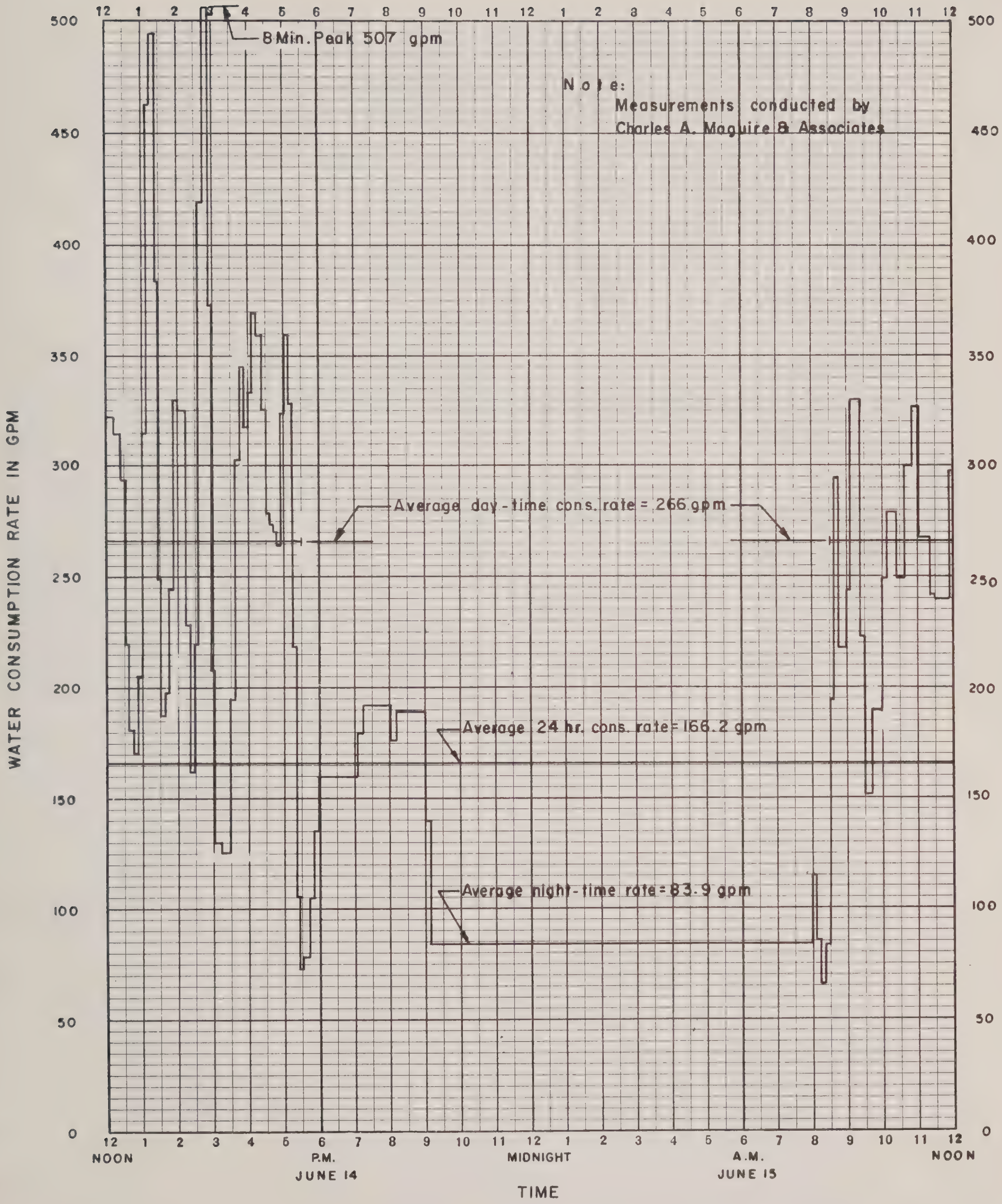


FIG. 20 FLUCTUATIONS IN WATER CONSUMPTION AT THE PRUDENTIAL PLAZA ON JUNE 14 & 15, 1966

TABLE II SUMMARY OF ESTIMATED SEWAGE FLOWS FOR ENTIRE CITY OF BOSTON

	Estimated Dry Weather Sewage Flow, mgd					
	1967		1995		2020	
Flow Component	Average Daily	Peak Rate	Average Daily	Peak Rate	Average Daily	Peak Rate
Sanitary Sewage						
Residents	35.2	--	75.0	--	115.0	--
Workers (Downtown only)	11.3	--	15.9	--	21.0	--
Transients (Downtown only)	1.0	--	1.8	--	2.7	--
Subtotal	47.5	101.0	92.7	185.0	138.7	277.4
Industrial Waste Water	52.5	--	61.3	--	73.8	--
Subtotal	100.0	200.0	154.0	308.0	212.5	425.0
Extraneous (Infiltration only)	51.0	82.0	50.0	78.0	48.5	73.0
Total	151.0	282.0	204.0	386.0	261.0	498.0
Portion of Total:						
to Deer Island Sewage Treatment Plant (including B.M.D.)	113.0					
to Nut Island Sewage Treatment Plant	38.0					

Note: These figures do not include storm water or tide water.

In the rational method the required capacity of a section of storm conduit is computed by the formula:

$$Q = C\ i\ A$$

in which:

Q = required capacity in cfs (cubic feet per second)

C = coefficient of runoff or per cent of rain reaching the conduit.

i = intensity of rainfall, in inches per hour, at the time of concentration for the particular reach of the conduit.

A = drainage area tributary to the particular reach of conduit, in acres.

The area "A" contributing runoff to the section of conduit being designed was measured by planimeter from maps on which the drainage areas had been outlined.

The intensity of rainfall "i" has been based upon the Weather Bureau Technical Paper No. 40 entitled "Rainfall Frequency Atlas of the United States", published in 1961. This paper presents rainfall frequency maps for selected duration and return periods based on a comprehensive and integrated collection of up-to-date statistics, including statistics for the various weather stations around Boston. On the basis of this paper, we have prepared a family of curves, which are shown on Fig. 21 showing the intensity of rainfall which may be expected to be equalled or exceeded, on the average, once in two, five, ten, fifteen, twenty-five and fifty years.

We have adopted a storm of 15-year frequency for the analysis and design of principal storm conduits. For times of concentration of less than 240 minutes, intensities for the 15-year storm obtained in this way are somewhat greater than those obtained by other methods based on shorter periods of record. For high-value business districts such as the Government Center Area, in which any flooding might result in heavy damage, storm drains should be designed for runoff resulting from a storm which will occur on the average once in 25 years. For enclosed, depressed areas subject to local critical flooding, consideration should be given to using greater intensities, i.e. for storms of 50 to 100 year frequency.

The peak rate of runoff in any section of a drainage system occurs at the time when all of the drainage area upstream from the section is contributing runoff. This time is that required for water to flow from the most remote part of the drainage area to the section of conduit under consideration and is numerically equal to the sum of the time for overland flow to an inlet (inlet time) and the time of flow in the drainage system to the section under consideration. The total time is called the time of concentration. We have used an inlet time of 5 minutes for the design of storm conduits in commercial and densely populated residential areas, and 15 minutes in other areas when conditions warranted. Estimated times of concentration range from less than

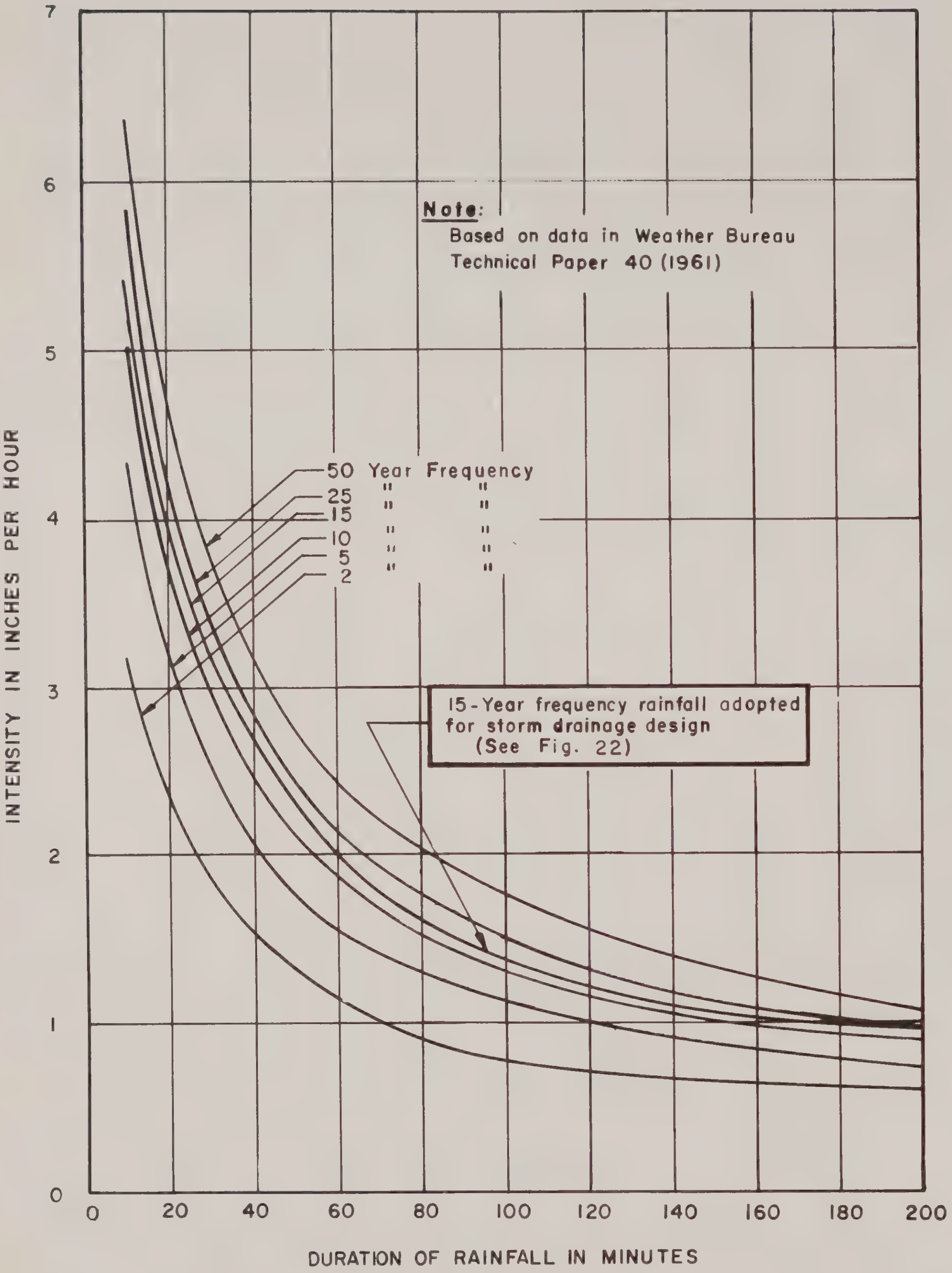


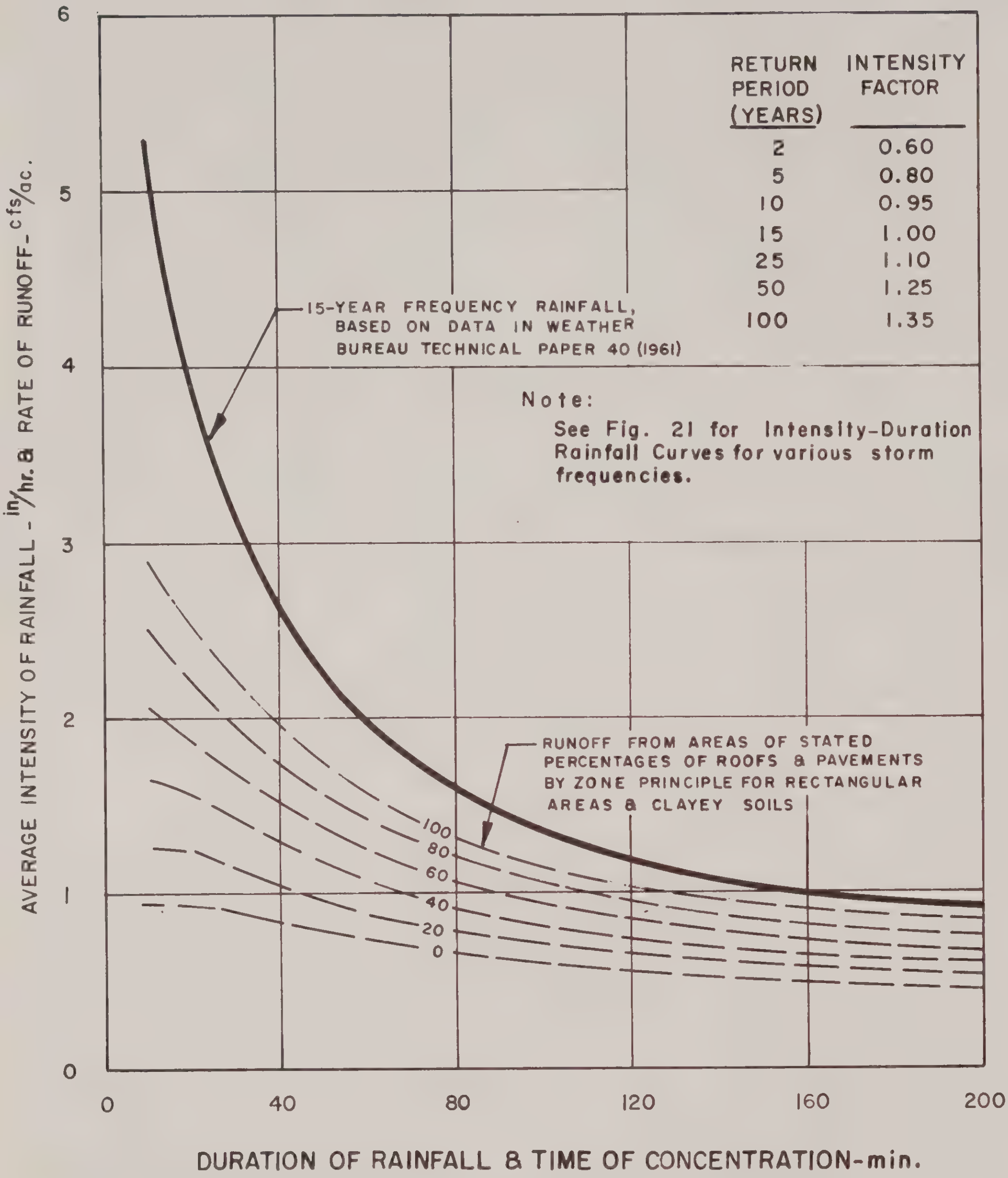
FIG. 21 INTENSITY-DURATION RAINFALL CURVES FOR BOSTON, MASSACHUSETTS

Camp, Dresser & McKee
Consulting Engineers
Boston, Mass.

20 minutes in downtown areas to about 3 hours for the downstream reaches of the Stony Brook Conduit.

A part of the water during a rainstorm seeps into the ground, and a part of it wets the surfaces and fills depressions. All of the water which falls as rain does not, therefore, appear as runoff during a storm. The ratio of the runoff to the intensity of rainfall at any time during the storm is called the coefficient of runoff. The coefficient increases during a storm because once the depressions are filled and the surfaces wetted, these elements cease to reduce the volume of runoff reaching the drainage works. The coefficient is greater for impervious surfaces, such as roofs and pavements, than for pervious surfaces, such as lawns and wooded areas, because less water is absorbed. We have used the runoff coefficients proposed by W. W. Horner for both pervious and impervious surfaces. Based on these coefficients, we have plotted a family of curves of runoff rates for areas having clayey soils and various percentages of roofs and pavements as shown on Fig. 22.

For our analyses of existing conduits and designs of proposed conduits, we have estimated from field reconnaissance and inspection of recent aerial photographs the percentages of roofs and pavements applicable to present conditions. We have used somewhat greater percentages in some of our estimates to allow for additional future development. As a result, estimated conduit capacities required to pass the 15-year frequency design storm runoff are in some cases greater than those which would be required if existing estimated percentages of roofs and pavements were considered to apply.



RETURN PERIOD (YEARS)	INTENSITY FACTOR
2	0.60
5	0.80
10	0.95
15	1.00
25	1.10
50	1.25
100	1.35

15-YEAR FREQUENCY RAINFALL, BASED ON DATA IN WEATHER BUREAU TECHNICAL PAPER 40 (1961)

Note:
See Fig. 21 for Intensity-Duration Rainfall Curves for various storm frequencies.

RUNOFF FROM AREAS OF STATED PERCENTAGES OF ROOFS & PAVEMENTS BY ZONE PRINCIPLE FOR RECTANGULAR AREAS & CLAYEY SOILS

FIG. 22 RAINFALL & RUNOFF FOR 15 YEAR FREQUENCY STORM AT BOSTON, MASS.

Camp, Dresser & McKee
Consulting Engineers
Boston, Mass.

VI SANITARY CONDITIONS OF BOSTON HARBOR AND ADJACENT WATERS

General

The sanitary conditions of Boston Harbor and adjacent waters have been the subject of many investigations and reports through the years, the most notable of which was that known as House Document 1600 published in 1936 by a Special Commission. This document, discussed in Appendix A of Vol 2, reported that portions of the harbor and tributary streams were seriously polluted at times by the overflow of sewage from outlets. Objectionable conditions due to the overflow of sewage along the waterfront of Boston Harbor were due to the inability of the sewerage systems to dispose of storm water along with the sanitary sewage entering the systems at times of storms.

Much of the Boston Sewerage System is a combined system as discussed in Chapter III. This means, that with rainfalls of even minor intensity, overflows of mixed sewage and storm water to nearby bodies of water occur. As discussed in Chapter V, such storms may be expected to occur on the average every 3 or 4 days. In sections of the sewerage system affected by tide water, not only do overflows occur during periods of storm water runoff, but tide water enters the system through outlets and regularly flushes out portions of the system.

The recently constructed MDC sewerage system has been designed for the collection and disposal of sanitary sewage and industrial wastes, as discussed in Chapter IV. It has hydraulic capacity for only a very minor amount of storm flow. Dry weather flows of sewage from most of Boston, including all of the area served by the Boston Main Drainage System, therefore, will enter the MDC system when it is completed, and will receive primary treatment at Deer Island before being discharged to sea. Since treated sewage and digested sludge will from the treatment plant be discharged into President Roads at the entrance to Boston Harbor, we would anticipate little or no improvement in harbor water quality to result from the operation of this plant. In addition, flows of mixed sewage and storm water as well as mixed sewage and tide water will continue to be discharged into Boston Harbor and adjacent waters, including the Charles River Basin, with resulting pollution of these waters.

Water Quality Characteristics

Bacteria and Viruses

The two most important water quality characteristics for Boston Harbor and adjacent waters, which bear upon their suitability for use are its content of bacteria and viruses.

Because most diseases which are known to be transmitted through water are of intestinal origin and the source of the causative organisms in water is human excreta, the presence of sewage in water is evidence of the possibility of the presence of infectious organisms. Sanitary sewage, or the liquid discharges from the sanitary and domestic conveniences of dwellings, public buildings or industries, contains the waste products of man's life processes, including disease causing organisms or pathogens. At present, the best evidence of recent fecal pollution is the presence of coliform bacteria whose normal habitat is the lower intestines of warm-blooded animals. About 100 to 400 billion coliform bacteria are excreted daily per person. These bacteria die off at about the same rate as pathogenic bacteria and therefore are measured as the indicator of pollution that is dangerous to the public health. The count of coliform bacteria is expressed in MPN (most probable number) per 100 ml (milliliter). Normal municipal sewage in dry weather contains about 50 to 300 million coliform bacteria per 100 ml. Standards of water quality discussed hereinafter assume that the numbers of infectious microorganisms of all types present at the source of pollution have been reduced at least in proportion to the reduction in the count of coliform bacteria. This assumption is probably warranted in the case of most pathogenic bacteria but is not warranted in the case of some viruses. Viruses are not removed by filtration to the same extent as bacteria, and some known viruses are more resistent to the usual dosages of chlorine.

Among the other water quality characteristics which affect the sanitary quality of the Boston Harbor and adjacent waters and its suitability for various uses are dissolved oxygen content, biochemical oxygen demand (BOD), temperature, chloride content, chemical constituents, ammonia, presence of odor, scum, floating solids or debris and sludge deposits. In Boston Harbor and adjacent waters, the evidence of pollution may be indicated by any of these characteristics in various locations.

Overflows of Mixed Sewage and Storm Water

As noted above, the sewerage system of Boston and several neighboring communities are combined systems carrying both sewage and storm water and in many cases tide water also. Combined sewers, to have adequate capacity for storm water runoff, should have capacities ranging from about 50 to 200 times the average dry weather flow of sewage, including infiltration. It is usually not economically feasible to intercept flows of this magnitude and subject it to the treatment required by receiving water standards. It has long been common practice, therefore, to design interceptors and treatment works with capacities for the peak dry weather flow or for flows from 2 to 5 times the average dry weather flow at the end of the design period and to permit overflows or discharges of mixed sewage and storm water at points of interception.

Many studies of combined sewerage systems in the United States, with interceptors designed for about twice the average dry weather flow, indicate that about 2 to 4 per cent of each year's production of sanitary sewage is lost from the system by overflows during rainstorms. A study conducted by Dr. Jack E. McKee in 1947, based on Boston rainfall data, showed that between 2 and 3 per cent of all sewage will reach the supposedly protected watercourses during the critical recreational months and that such overflows will occur 5 or 6 times each month on the average. About 50 per cent of the sewage will overflow during a rainstorm having an intensity of 0.05 inches per hour, and about 90 per cent of the sewage will overflow at a rainfall intensity of 0.20 inches per hour. Thus, large slugs of pollution of intestinal bacteria and viruses, as well as BOD and suspended solids, will be discharged to the receiving waters nearly every time it rains. In our opinion, such waters are not safe for either bathing or recreation.

Studies of the chlorine demand of the Buffalo, New York sewage during the years 1938 and 1940 by Symons, et al (Sewage Works Journal 13, 249, 1941) indicate a considerable scour of sewer deposits for many hours after the start of a storm. Studies by Riis-Carstensen (Sewage and Industrial

Wastes, 27, 1115, 1955) of gagings and analyses of Buffalo sewage in the Bird Avenue district during August, 1936 throw light on the suspended solids discharge and overflows. A rainstorm amounting to 0.52 inches started at 5:30 PM and ended at 9:00 PM. The rainfall intensity averaged 0.16 inches per hour. The maximum gaged rate of flow corresponded with a dilution ratio of only 5.2 times the average dry weather flow. The rate of flow of suspended solids by weight during runoff from the rainstorm reached 29.3 times the dry weather rate and averaged 11.8 times the dry weather rate. From the data collected by Symons, et al and from Carstensen's studies, Camp (Water and Its Impurities, page 216, Reinhold, 1963) has estimated that 35 per cent or more of the years production of suspended solids at Buffalo may be discharged in the overflows of mixed sewage and storm water, despite the fact that only 3 per cent of the sanitary sewage is discharged untreated through the overflows. No data are available on the per cent loss of coliform bacteria in overflows of mixed sewage and storm water.

Based on analyses and flow measurements made over the 2 year period, 1960 to 1961, at Northampton England, estimates were made of the yearly discharge of BOD and suspended solids in overflows of mixed sewage and storm water for various interceptor capacities. Results indicate that for interceptors designed with capacities of 3 times the average dry weather flow, about 8.1 per cent of the annual BOD and about 27.4 per cent of the annual suspended solids will be lost in the overflows. These percentages decrease with increases in capacity of the interceptors. The combined sewers in Northampton have relatively high velocities. It may be expected, therefore, that for combined systems with relatively flat slopes such as those in Boston, the loss of BOD and suspended solids will be much greater.

Evidence of the discharge of suspended solids through outlets from the combined sewerage systems in Boston may be seen in the form of sludge banks which appear at low tide in Old Harbor facing Carson Beach, L Street Beach, and other recreation areas in South Boston, as well as in the form of accumulations of grease balls on the beach areas under certain conditions of wind and tide..

Water Quality Sampling Program

To provide evidence of pollution from discharges of mixed sewage and storm water, a limited water quality sampling program was undertaken as part of our studies in October, 1966. It was considered particularly important to obtain such evidence in waters used for recreation. Therefore, a series of grab samples was taken of water from Old Harbor (Carson Beach), Charles River Basin, Malibu Beach, and Tenean Beach as shown on Table 12.

Records of analyses made available to us prior to undertaking this sampling program indicated that serious pollution did exist in the Charles River Basin but to lesser extent at Carson Beach, Tenean Beach, and Malibu Beach. We, therefore, determined that it would be necessary for us to carefully choose the desired conditions of wind, tide and weather to determine if serious pollution did indeed exist at all these locations. In general, the most desirable time for sampling at each point was considered to be

TABLE 12 WATER QUALITY IN VICINITY OF COMBINED SEWER OUTLETS

SAMPLING POINT LOCATION	COLIFORM BACTERIA PER 100 ML. on Date Shown (October 1966)								
	10/3	10/4	10/5	10/6	10/10	10/11	10/13	10/19	10/20
A - 50 ft West of Stony Brook outlet, Charles River Basin (Outlet No. 45)	-	10,000	180,000	440,000	500,000	700,000	800,000	45,000	38,000
B - Over Berkeley Street outlet, Charles River Basin (Outlet No. 48)	-	12,000	130,000	37,000	50,000	4,000	12,000	78,000	76,000
C - 100 ft West of "N" Street outlet, South Boston (Outlet No. 94)	600	140	320	680	500	220	770	1,800	1,400
D - 50 ft West of "K" Street outlet, L Street Beach (Outlet No. 95)	1,400	500	500	1,000	24,000	650	540	8,000	4,500
E - 500 ft Northeast of MDC Bathhouse, Carson Beach (Outlet Nos. 97 and 98)	2,000	3,800	2,200	1,500	1,100	80	1,400	3,000	2,600
F - 300 ft Northwest of Park Pavilion, at south end of Carson Beach (Outlet No. 99)	300	100	430	800	4,000	290	660	1,600	1,900
G - 50 ft North of Yacht Club, Malibu Beach, Dorchester (Outlet No. 100)	200	300	200	2,200	690	80	4,600	24,000	2,500
H - North end of Tenean Beach, Dorchester	500	400	700	280	240	260	1,000	20,000	2,100

NOTES:
1. Grab samples taken by Camp, Dresser & McKee
2. Laboratory analyses performed by MDC Water Division

immediately following rainfalls causing overflows. Samples, however, were taken at different stages of the tide and under different weather conditions.

Most grab samples were taken about 25 to 30 ft off shore and in about 2 to 3 ft of water. Samples were taken in 100 ml bottles provided by the MDC and were taken to the MDC Water Division laboratory for analyses. The results of the analyses of these grab samples are presented in Table 12.

It will be noted from the results shown on Table 12 that the highest concentrations of coliform bacteria were found in the Charles River Basin near the outlet to Stony Brook and the Berkeley Street outlet from the Boston Marginal Conduit. Weather conditions during the period of sampling were generally dry between October 3 and October 13, but included significant rainfall on October 19 and 20. It is evident from the results shown for sampling point locations C through H that concentrations of coliform bacteria were significantly greater during the wet weather period than for the preceding dry weather period. Since these six points are in areas used for recreational bathing and shellfish taking, significant hazards to health are presented by discharges of mixed sewage and storm water.

Recreational use of the Charles River Basin is principally in the form of boating, water skiing, and sailing. Such uses include water contact at times. Therefore, the health hazards presented by pollution of the Charles River Basin are considered to be as great as those presented at bathing beaches.

Standards of Water Quality

In accordance with the provisions of Chapter 685 of the Acts of 1966, the Massachusetts Division of Water Pollution Control has recently adopted water quality standards and classifications for the inland and tidal waters of the Commonwealth. The standards became effective on March 6, 1967 and the classifications on June 20, 1967. These standards and classifications have been submitted to and approved by the Federal Water Pollution Control Administration (FWPCA) in accordance with the provisions of the Federal Water Pollution Control Act (Public Law 84-660) as amended by the Water Quality Act of 1965.

In the classification of waters, consideration is given by the Division of Water Pollution Control to all factors involved including public health, public enjoyment, propagation and protection of fish and wild life, and economic and social development. The standards of water quality for Class B and Class C Fresh Waters are shown on Table 13, and the standards of water quality for coastal and marine waters are shown on Table 14.

The classifications of fresh waters and marine and coastal waters in the Boston area were based on analyses made by the State and are shown on Fig. 23. From this figure it is seen that the Charles River Basin and Neponset River have fresh water classifications of C and the marine and coastal water classifications are as follows: Boston Inner Harbor, SC; Boston Outer Harbor, SB; and beyond a line from Deer Island to Hull, SA.

The Federal Government conducted a sampling program of harbor waters in the summer of 1967 in cooperation with the MDC and the Massachusetts

Division of Water Pollution Control. The results of this sampling program have not yet been published, but it is reported that dissolved oxygen levels were above 5.0 ppm at all sampling points.

It appears to be no less expensive to meet Class C and SC requirements than Class B and SB so far as mixed sewage and storm water overflows are concerned. It is concluded, therefore, that if harbor waters are to be made suitable for the proposed uses, the solution must include the elimination of sewage overflows into the harbor waters and into the estuaries; that is, the Charles River, Neponset River and Mystic River. Otherwise, the harbor waters will continue to be polluted by the discharges from the estuaries.

TABLE 13 STANDARDS OF WATER QUALITY - FRESH WATERS

Class B - Suitable for bathing and recreational purposes including water contact sports. Acceptable for public water supply with appropriate treatment. Suitable for agricultural, and certain industrial cooling and process uses; excellent fish and wildlife habitat; excellent aesthetic value.

Standards of Quality

Item	Water Quality Criteria
1. Dissolved oxygen	Not less than 75% of saturation during at least 16 hours of any 24-hour period and not less than 5 mg/l at any time.
2. Sludge deposits-solid refuse-floating solids-oils-grease-scum	None allowable
3. Color and turbidity	None in such concentrations that would impair any usages specifically assigned to this class.
4. Coliform bacteria per 100 ml	Not to exceed an average value of 1000 during any monthly sampling period nor 2400 in more than 20% of samples examined during such period.
5. Taste and odor	None in such concentrations that would impair any usages specifically assigned to this class and none that would cause taste and odor in edible fish.
6. pH	6.5 - 8.0
7. Allowable temperature increase	None except where the increase will not exceed the recommended limit on the most sensitive receiving water use and in no case exceed 83°F in warm water fisheries, and 68°F in cold water fisheries, or in any case raise the normal temperature of the receiving water more than 4°F.

TABLE 13 STANDARDS OF WATER QUALITY - FRESH WATERS (Continued)

8. Chemical constituents	None in concentrations or combinations which would be harmful or offensive to human, or harmful to animal or aquatic life or any water use specifically assigned to this class.
9. Radioactivity	None in concentrations or combinations which would be harmful to human, animal, or aquatic life for the appropriate water use. None in such concentrations which would result in radio-nuclide concentrations in aquatic life which exceed the recommended limits for consumption by humans.
10. Total phosphate	Not to exceed an average of 0.05 mg/l as P during any monthly sampling period.
11. Ammonia	Not to exceed an average of 0.5 mg/l as N during any monthly sampling period.
12. Phenols	Shall not exceed .001 mg/l at any time.

Class C - Suitable for recreational boating; habitat for wildlife and common food and game fishes indigenous to the region; certain industrial cooling and process uses; under some conditions acceptable for public water supply with appropriate treatment. Suitable for irrigation of crops used for consumption after cooking. Good aesthetic value.

Standards of Quality

Item	Water Quality Criteria
1. Dissolved Oxygen	Not less than 5 mg/l during at least 16 hours of any 24-hour period nor less than 3 mg/l at any time. For seasonal cold water fisheries at least 5 mg/l must be maintained.

TABLE 13 STANDARDS OF WATER QUALITY - FRESH WATERS (Continued)

2.	Sludge deposits-solid-refuse floating solids-oils-grease-scum	None allowable except those amounts that may result from the discharge from waste treatment facilities providing appropriate treatment.
3.	Color and turbidity	None allowable in such concentrations that would impair any usages specifically assigned to this class.
4.	Coliform bacteria	None in such concentrations that would impair any usages specifically assigned to this class.
5.	Taste and odor	None in such concentrations that would impair any usages specifically assigned to this class, and none that would cause taste and odor to edible fish.
6.	pH	6.0 - 8.5
7.	Allowable temperature increase	None except where the increase will not exceed the recommended limits on the most sensitive receiving water use and in no case exceed 83° F in warm water fisheries, and 68°F in cold water fisheries, or in any case raise the normal temperature of the receiving water more than 4°F.
8.	Chemical constituents	None concentrations or combinations which would be harmful or offensive to human, or harmful to animal or aquatic life or any water use specifically assigned to this class.
9.	Radioactivity	None in concentrations or combinations which would be harmful to human, animal, or aquatic life for the appropriate water use. None in such concentrations which would result in radio-nuclide concentrations in aquatic life which exceed the recommended limits for consumption by humans.

TABLE 13 STANDARDS OF WATER QUALITY - FRESH WATERS
(Continued)

10.	Total phospahte	Not to exceed an average of 0.05 mg/l as P during any monthly sampling period.
11.	Ammonia	Not to exceed an average of 1.0 mg/l as N during any monthly sampling period.
12.	Phenols	Not to exceed an average of 0.002 mg/l at any time.

Notes:

1. All wastes shall receive appropriate waste treatment which is defined as secondary treatment with disinfection or its industrial waste treatment equivalent except when a higher degree of treatment is required to meet the objectives of the water quality standards, all as determined by the Division of Water Pollution Control. Disinfection from October 1 to May 1 may be discontinued at the discretion of the Division of Water Pollution Control.

2. Appropriate water supply treatment is as determined by the Massachusetts Department of Public Health.

3. These water quality standards do not apply to conditions brought about by natural causes.

4. Class B, & C waters shall be substantially free of pollutants that will:

   (1) unduly affect the composition of bottom fauna

   (2) unduly affect the physical or chemical nature of the bottom

   (3) interfere with the spawning of fish or their eggs

5. The average minimum consecutive 7 day flow to be expected once in ten years shall be used in the interpretation of the standards except where noted.

6. The amount of disinfection required shall be equivalent to a free and combined chlorine residual of at least 1.0 mg/l after 15 minutes contact time during peak hourly flow or maximum rate of pumpage.

7. Class A and Class D standards have been omitted from this table.

TABLE 14 STANDARDS OF WATER QUALITY
COASTAL AND MARINE WATERS

Class SA - Suitable for any high quality water use including bathing and water contact sports. Suitable for approved shellfish areas.

Standards of Quality

Item	Water Quality Criteria
1. Dissolved oxygen	Not less than 6.5 mg/l at any time.
2. Sludge deposits-solid refuse-floating solids-oil-grease-scum	None allowable
3. Color and turbidity	None in such concentrations that will impair any usages specifically assigned to this class.
4. Coliform bacteria per 100 ml	Not to exceed a median value of 70 and not more than 10% of the samples shall ordinarily exceed 230 during any monthly period.
5. Taste and odor	None allowable
6. pH	6.8 - 8.5
7. Allowable temperature increase	None except where the increase will not exceed the recommended limits on the most sensitive water use.
8. Chemical constituents	None in concentrations or combinations which would be harmful to human, animal, or aquatic life or which would make the water unsafe or unsuitable for fish or shellfish or their propagation, impair the palatability of same, or impair the water for any other uses.

TABLE 14 STANDARDS OF WATER QUALITY
COASTAL AND MARINE WATERS
(Continued)

9. Radioactivity	None in concentrations or combinations which would be harmful to human, animal, or aquatic life for the designated water use. None in such concentrations which would result in radio-nuclide concentrations in aquatic life which exceed the recommended limits for consumption by humans.
10. Total phosphate	Not to exceed an average of 0.07 mg/l as P during any monthly sampling period.
11. Ammonia	Not to exceed an average of 0.2 mg/l as N during any monthly sampling period.

Class SB - Suitable for bathing and recreational purposes including water contact sports; industrial cooling; excellent fish habitat; good aesthetic value; and suitable for certain shellfisheries with depuration. (Restricted Shellfish Areas).

Standards of Quality

Item	Water Quality Criteria
1. Dissolved oxygen	Not less than 5.0 mg/l at any time.
2. Sludge deposits-solid refuse-floating solids-oils-grease-scum	None allowable
3. Color and turbidity	None in such concentrations that would impair any usages specifically assigned to this class.
4. Coliform bacteria per 100 ml	Not to exceed a median value of 700 and not more than 2300 in more than 10% of the samples during any monthly sampling period.
5. Taste and odor	None in such concentrations that would impair any usages specifically assigned to this class and none that would cause taste and odor edible fish or shellfish.

TABLE 14 STANDARDS OF WATER QUALITY
COASTAL AND MARINE WATERS
(Continued)

6. pH	6.8 - 8.5
7. Allowable temperature increase	None except where the increase will not exceed the recommended limits on the most sensitive water use.
8. Chemical constituents	None in concentrations or combinations which would be harmful to human, animal or aquatic life or which would make the waters unsafe or unsuitable for fish or shellfish or their propagation, impair the palatability of same, or impair the water for any other usage.
9. Radioactivity	None in concentrations or combinations which would be harmful to human, animal, or aquatic life for the appropriate water use. None in such concentrations which would result in radio-nuclide concentrations in aquatic life which exceed the recommended limits for consumption by humans.
10. Total phosphate	Not to exceed an average of 0.07 mg/l as P during any monthly sampling period.
11. Ammonia	Not to exceed an average of 0.2 mg/l as N during any monthly sampling period.

Class SC - Suitable for aesthetic enjoyment; for recreational boating; habitat for wildlife and common food and game fishes indigenous to the region; industrial cooling and process uses.

Standards of Quality

Item	Water Quality Criteria
1. Dissolved oxygen	Not less than 5 mg/l during at least 16 hours of any 24-hour period nor less than 3 mg/l at any time.

TABLE 14 STANDARDS OF WATER QUALITY COASTAL AND MARINE WATERS (Continued)

2.	Sludge deposits-solid refuse-floating solids-oils-grease-scum	None except that amount that may result from the discharge from a waste treatment facility providing appropriate treatment.
3.	Color and turbidity	None in such concentrations that would impair any usages specifically assigned to this class.
4.	Coliform bacteria	None in such concentrations that would impair any usages specifically assigned to this class.
5.	Taste and odor	None in such concentrations that would impair any usages specifically assigned to this class and none that would cause taste and odor in edible fish or shellfish.
6.	pH	6.5 - 8.5
7.	Allowable temperature increase	None except where the increase will not exceed the recommended limits on the most sensitive water use.
8.	Chemical constituents	None in concentrations or combinations which would be harmful to human, animal or aquatic life or which would make the waters unsafe or unsuitable for fish or shellfish or their propagation, impair the palatability of same, or impair the water for any other usage.
9.	Radioactivity	None in such concentrations which would be harmful to human, animal or aquatic life for the designated water use. None in such concentrations which would result in radio-nuclide concentrations in aquatic life which exceed the recommended limits for consumption by humans.

TABLE 14 STANDARDS OF WATER QUALITY COASTAL AND MARINE WATERS (Continued)

10. Total phosphate	Not to exceed an average of 0.07 mg/1 as P during any monthly sampling period.
11. Ammonia	Not to exceed an average of 1.0 mg/1 as N during any monthly sampling period.

Notes:

1. Coastal and marine waters are those subject to the rise and fall of the tide.

2. Appropriate treatment is defined as the degree of treatment with disinfection required for the receiving waters to meet their assigned state or interstate classification and to meet the objectives of the water quality standards. Disinfection from October 1 to May 1 may be discontinued at the discretion of the Division of Water Pollution Control.

3. The water quality standards do not apply to conditions brought about by natural causes.

4. The waters shall be substantially free of pollutants that will:

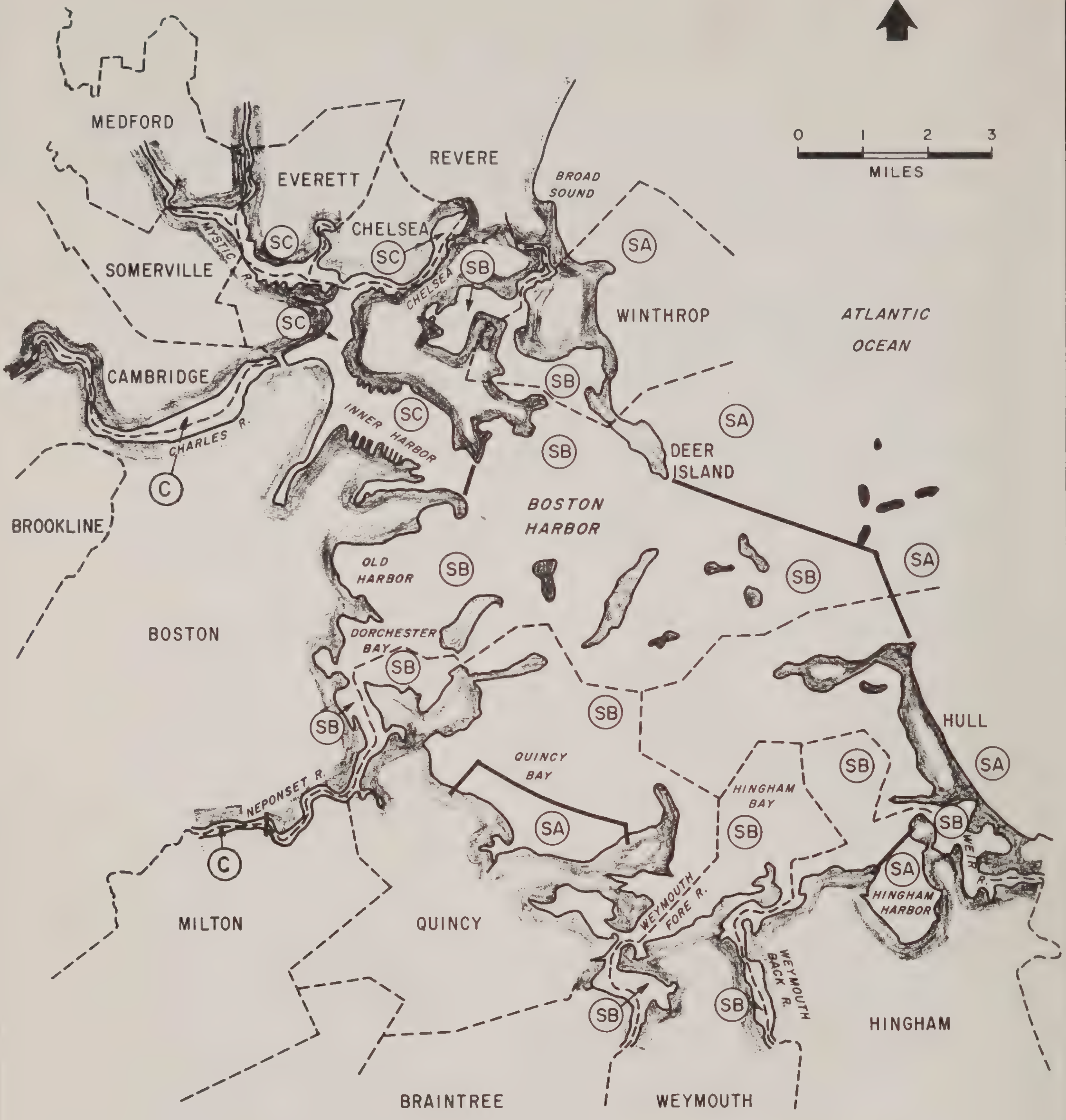
   (1) unduly affect the composition of bottom fauna

   (2) unduly affect the physical or chemical nature of the bottom

   (3) interfere with the spawning of fish or their eggs

5. The standards shall apply at all times in coastal and marine waters

6. The amount of disinfection required shall be equivalent to a free and combined chlorine residual of at least 1.0 mg/1 after 15 minutes contact time during peak hourly flow or maximum rate of pumpage.



COMMONWEALTH OF MASSACHUSETTS
WATER RESOURCES COMMISSION

BOSTON HARBOR CLASSIFICATION

WATER USE CLASSES - Ⓐ Ⓑ Ⓒ Ⓓ (SA) (SB) (SC)

— CHANGE CLASSIFICATION

FIG. 23

VII ALTERNATIVE METHODS OF POLLUTION ABATEMENT

General Discussion

We have studied four principal alternative methods of pollution abatement for Boston Harbor and adjacent waters in order to determine the most feasible method. The criteria for designing proposed intercepting sewers depended upon this determination. Each of the four methods could result in the significant reduction of discharges of mixed sewage and storm water to nearby watercourses, and either provide a degree of treatment for such flows or carry them to a point where additional treatment may not be needed. The water quality in Boston Harbor and adjacent waters is discussed in Chapter VI.

The four methods which have been studied are:

1. Complete separation of all sanitary sewerage and storm drainage systems in areas now served by combined sewers.

2. Construction of chlorination detention tanks at selected locations to receive flows from tributary combined sewerage systems of mixed sewage and storm water in excess of dry weather interceptor capacities, detain the flows to provide chlorine contact time for disinfection and discharge chlorinated flows to nearby watercourses or to the harbor.

3. Construction of surface holding tanks at selected locations to receive flows from tributary combined sewerage systems of mixed sewage and storm water in excess of dry weather interceptor capacities, and discharge untreated flows to the dry weather interceptors following storms.

4. Construction of the Deep Tunnel Plan with storage tunnels located in bedrock to receive flows of mixed sewage and storm water in excess of dry weather interceptor capacities, and screen, chlorinate and pump flow through an outfall and diffusers for disposal at sea.

The first three methods of solving the problem of combined sewers, listed above, are those which have been most commonly used in the U.S. to date. However, they each have major disadvantages as discussed hereinafter.

The Federal Government has recognized this situation and during 1965 enacted legislation that provides for research and demonstration grants under the Federal Water Pollution Control Administration in an effort to develop new methods. This legislation has stimulated research, and a number of municipalities throughout the U.S. have received grants to study among other possibilities, holding and treatment lagoons, more efficient control of flow volume from combined sewers into interceptors, the feasibility of digging wells to lower ground water tables and reduce infiltration, the investigation of storing overflows in deep rock storage tunnels, and a study being conducted by the American Society of Civil Engineers on the feasibility of pumping sanitary sewage from buildings through small diameter pressure lines placed inside existing combined sewers.

In our opinion, the handling of mixed sewage and storm water overflows in deep rock storage tunnels is better adapted to the requirements of the Boston area than the other methods enumerated above.

To provide effective pollution abatement of Boston Harbor and adjacent waters, any method must encompass areas contributing pollution which are located outside of Boston itself. It must, therefore, include, in addition to Boston, all communities contributing overflows of mixed sewage and storm water to Boston Harbor and adjacent waters. To provide the City of Boston with alternative approaches, we have estimated costs for Boston alone, Boston and Brookline, and the regional area consisting of Boston, Brookline, Cambridge, Chelsea and Somerville.

Each of the four principal alternative methods of solving the problem of combined sewer overflows is described hereinafter, and estimated costs for each are presented. Estimated costs of proposed dry weather interceptors are required for each method and have therefore not been included in these estimates. Such costs are presented in Chapters VIII and IX.

Complete Separation

Description

The most positive method of separating storm water and sewage flows is at their sources by providing completely separate sanitary sewerage and storm drainage systems. This method would eliminate all discharges or overflows of mixed sewage and storm water. In Boston and neighboring communities, this would require the construction of one or more new sanitary sewers in every street where combined sewers now exist. It would also involve new separate plumbing connections to most of the existing buildings, and the replumbing of many entire buildings to separate roof drainage from sanitary sewage. In many areas, yard drainage which now discharges into the combined system would also have to be repiped to the separate storm water systems. The construction of new separate sanitary sewers in the combined areas of the city would require the digging-up of every street and result in enormous traffic problems that would interfere with every day activities.

We have considered that separation of sanitary sewerage and storm drainage systems would be necessary in all areas now served by combined sewers. An estimated 7,000 acres are presently served totally and directly by combined sewers in Boston and would therefore be included under a city-wide separation scheme. An additional area of approximately 13,500 acres in Boston is now served directly by separate systems of sewerage and drainage.

If combined sewer areas in Brookline were separated along with those in Boston, the total area requiring separation would be about 7,400 acres. If combined areas in the five communities comprising the regional area were separated, a total of approximately 12,000 acres would be involved. Approximately 5,000 additional acres within these five communities are now served directly by separate local systems of sewerage and drainage but discharge to combined sewers.

The difficulties to be encountered in a program of building-plumbing separation are of almost infinitely variable nature and complexity. If the City were to require such separation at the owners' expense, the problem of enforcement would be huge. Such enforcement would have to be carried out under city ordinance by teams of inspectors.

On the other hand, the City or other public agency might itself assume the task and cost of separation of building plumbing since it seem unlikely that most owners would be willing to make expenditures for the necessary work. In addition, the separation of building plumbing would, in many cases, require extensive renovations to the buildings themselves.

It is recognized that separation has been the policy of the city since 1967, and that recent and current urban renewal projects provide for separation.

Based on recent experience of separation in other cities, it is our considered opinion that 100 per cent building plumbing separation is not a feasible objective, particularly in older built-up areas of major cities. Unless such a separation program can be 100 per cent accomplished, pollution abatement by this method cannot be accomplished.

Estimated Costs of Separation

In developing the street sewer separation costs presented below, we have considered that no storm water would enter any sanitary sewers. In other words, new sanitary street sewers required under this method would be designed only for peak dry weather sewage flow rates including infiltration.

Cost estimates for complete separation were made after preparing preliminary designs of new sanitary sewers to serve four specific areas of Boston considered to be representative of the presently combined sewered area. These representative study areas are located in Jamaica Plain, South Boston, Back Bay, and downtown Boston. Estimated street sanitary sewer construction costs for these areas range from $8,500 per acre in Jamaica Plain to $54,000 per acre in downtown Boston. Applying the unit costs to the entire 7,000 acre area within Boston now served directly by combined sewers results in a total estimated construction cost for new street sanitary sewers of about 147 million dollars or an average of $21,000 per acre. For Boston and Brookline the total estimated construction cost on this basis would be 156 million dollars and for the regional area 252 million dollars, as shown in Table 15 .

Cost estimates for the separation of plumbing in existing buildings have been made based upon the cost of such work recently accomplished in Washington, D.C. and estimates made for New York City. We have used an average cost of $1,850 per building for one, two and three family residential areas and $5,000 per building in moderate to high density residential areas and commercial areas. If all existing buildings within the 7,000 acre combined sewer area within Boston were considered to require plumbing separation, the estimated cost for building plumbing separation would average about $33,000 per acre. Of course, not all existing buildings within the combined sewer area require separation. Some are now provided with separate storm (roof, basement and yard drains) and sanitary plumbing. Since an estimated 75 per cent of existing buildings in Boston now have common systems of sewerage and drainage, and thus

TABLE 15 ESTIMATED COSTS OF SEPARATION AND AREAS SERVED

Item	Boston	Boston and Brookline	Regional Area (5 Cities)
		Areas Served	
Estimated Construction Costs, Million Dollars			
Street Sanitary Sewers only	147.0	156.0	252.0
Street Sanitary Sewers and Building Plumbing	320.0	340.0	550.0
Street Sanitary Sewers, Building Plumbing and Storm Drains	400.0	423.0	685.0
Estimated Annual Operation and Maintenance Costs, Million Dollars			
Street Sanitary Sewers	0.805	0.850	1.375
Tributary Area, Acres	7,000	7,400	12,000

would require separation, the estimated additional cost of such building separation would be about 173 million dollars.

Based on the above, the total estimated construction cost would be about 322 million dollars at an average cost of $46,000 per acre. Comparable estimates for Boston and Brookline together and for the five city regional areas would be about 340 million dollars and 550 million dollars respectively, as shown on Table 15. These figures have been used for comparison with other alternative methods. Costs of required new storm or combined conduits are considered to be the same for each method and are discussed below.

The above costs do not include those for any new street storm drains. However, many existing combined sewers require greater capacity and others are known to be in poor condition. If a completely new system of separate street storm drains were required, the estimated cost of such a system might be approximately 150 million dollars based on an analysis of comparative construction costs of separate sanitary sewers and storm drains made in New York City. Therefore, we estimate that a complete Boston separation program might cost upwards of 470 million dollars. Because many existing combined sewers will not require replacement or relief, we estimate a total construction cost of about 400 million dollars for the separation of sewage flows and storm water from 7,000 acres in Boston. This would be equivalent to an average estimated total separation cost for construction of approximately $57,000 per acre.

Based upon this overall average separation cost, the estimated costs of separating the 7,400 acres in Boston and Brookline would be about 423 million dollars and for the 12,000 acres in the regional area of Boston, Brookline, Cambridge, Chelsea and Somerville would be about 685 million dollars as shown in Table 15.

Estimated annual costs of operation and maintenance are shown in Table 15. We have used 0.25 per cent of the estimated construction costs as the basis of these costs.

Construction of Chlorination Detention Tanks

Description

The second alternative method of handling mixed sewage and storm water discharges is to construct chlorination detention tanks in the vicinities of selected outlets, which would collect, detain and adequately chlorinate discharges or overflows of dry weather flow or mixed sewage and storm water before discharging to nearby watercourses. In our investigation of this method, we have considered that chlorination contact tanks, to be effective, should provide a minimum detention period of 10 minutes for peak flows resulting from a 15-year frequency design storm. We have based our estimates of flow upon an average time of concentration to the tanks of 30 minutes. The rate of runoff which we have used to determine required tank sizes, therefore, is 2.07 cfs per acre from the tributary areas.

Based upon our study of Boston outlets as described in Chapter III and Appendix D, we estimate that about 30 chlorination detention tanks would be required for the approximately 90 outlets serving about 10,300 acres now tributary to combined sewer outlets in Boston. About 45 tanks would be required to serve the regional area. The tanks would receive all flows from tributary conduits in excess of interceptor capacities and provide 10 minute contact time for a hypochlorite solution dosage of 30 ppm.

Due to the low elevations of most conduits entering the tanks and the varying water levels of the receiving bodies of water, we consider that practically all flows would require pumping except when tanks are full and receiving water levels are low. In addition, it would be necessary to provide screening and grit removal facilities to facilitate maintenance and cleaning operations. Velocities through the tanks would be kept as high as possible consistent with providing the required minimum detention time, but sludge removal and handling facilities would be required. With these facilities chlorination detention tanks become in effect primary treatment plants.

It is essential for the proper operation of these chlorination detention tanks that tributary combined sewers be adequately sized to carry the required storm runoff. A principal advantage of this method is that all flows of mixed sewage and storm water receive some treatment before being discharged to receiving waters.

The chief disadvantage of chlorination detention tanks is that while they would remove bacteria and viruses, they would not affect the discharge of putrescible organic matter. Additional disadvantages of chlorination detention tanks are the land required and the enormous problem of operation and maintenance. Near each outlet or combination of outlets must be available sufficient land area for construction of such tanks in order to make this method feasible. It is not considered feasible to construct the large conduits required to connect many outlets to a single tank because the areas tributary are large enough to make the sizing of such conduits impractical. We estimate that a minimum land area of approximately 98 acres would be required for the tank sites serving Boston only, 102 acres for Boston and Brookline and 162 acres for the regional area. These areas are based upon an average liquid depth of about 12 ft. Most of these sites would be located in or near congested areas where land is at a premium. About 30 tank sites in Boston and 15 additional sites serving neighboring communities would be required.

Operation and maintenance of these treatment facilities would require a very large staff of trained personnel. We estimate that about 185 men would be required to serve about 30 tanks and about 275 for 45 tanks, including supervisory personnel. These estimates are based upon having 2 men present at large plants at all times and 1 man at smaller plants.

Estimated Costs of Chlorination Detention Tanks

The estimated costs of chlorination detentions tanks are shown in Table 16. Estimated construction costs include the costs for such items as land for tank sites, combined flow conduits to tank sites and new separate sanitary sewers required in presently combined areas not served by chlorination detention tanks. Tank site costs include the cost of land, building acquisition, and building demolition cost as applicable, and have been based upon estimates for such costs for recent real estate transactions in various parts of the city.

TABLE 16 ESTIMATED COSTS OF CHLORINATION DETENTION TANKS AND AREAS SERVED

Item	Areas Served Boston	 Boston and Brookline	 Regional Area (5 Cities)
Estimated Construction Costs, Million Dollars			
Tank Sites	34.0	35.0	56.0
Chlorination Detention Tanks	182.0	190.0	305.0
Conduits	18.0	18.0	29.0
Separation	6.0	7.0	10.0
TOTAL ESTIMATED CONSTRUCTION COST	240.0	250.0	400.0
Estimated Annual Operation and Maintenance Costs, Million Dollars	3.330	3.470	5.310
Tributary Area, Acres	10,300	10,700	17,000

Land for this method, if it were available, could be obtained only at high cost. Such use of this land would in addition prevent it from being used for recreational, business or residential purposes.

We estimate that the construction costs for chlorination detention tanks would be 240 million dollars for Boston, 250 million dollars for Boston and Brookline and 400 million dollars for the regional area as shown in Table 16 . Estimated annual costs of operation and maintenance shown in this table include costs for labor, electric power, sodium hypochlorite solution and maintenance and repair. Estimated costs of maintenance and repair are based on 1.00% of construction costs for equipment, 0.50% for structures and 0.25% for conduits and separate sanitary sewers.

Construction of Holding Tanks

Description

The third alternative method for handling discharges of mixed sewage and storm water is to construct holding tanks in the vicinities of selected outlets. These tanks would store discharges or overflows until the storm subsided. The stored flows then could be released back into the dry weather interceptor system for disposal to the MDC sewerage system with the normal sewage flow. Because the entire overflow volume for the 15-year frequency design storm would have to be stored, the holding tanks would be larger than the chlorination detention tanks described above, and more land area would be required. The total volume of runoff from such a rainstorm is approximately 16,300 cu ft per acre resulting from a total storm runoff equivalent to approximately 4.5-in over the tributary areas.

As discussed above for chlorination detention tanks, we similarly estimate that about 30 holding tanks would be required for the approximately 90 outlets serving about 10,300 acres now tributary to combined sewer outlets in Boston and about 45 would be required to serve the regional area. Surface holding tanks would receive all flows in excess of the capacity of dry weather flow interceptors up to the design volume of the tanks. For a storm contributing a total volume of runoff in excess of that anticipated for a 15-year storm frequency, overflows would take place to the harbor untreated by operating remote controlled diversion facilities. Provision of chlorination facilities to avoid such occurrences would increase the cost of this method, and in effect we would then have a series of very large chlorination detention tanks.

Normal operation of the holding tanks would be such that upon cessation of the storm producing flows in excess of dry weather interceptor capacities, runoff to the holding tanks would gradually diminish and the outflow from the tanks would exceed the rate of inflow. Because it is essential that the tanks be drawn completely down within a period of no more than 3 to 4 days in order that they be ready to receive runoff from the next rain storm, it is essential that the dry weather flow interceptors be adequately sized. Most existing interceptors serving the City of Boston are of inadequate capacity for peak dry weather flows anticipated in the year 2020 to permit drawdown of the tanks within the required period. For this reason, it is essential that all dry weather flow interceptors be provided with adequate capacity in order for this alternative method to operate properly.

One of the advantages of holding tanks over chlorine contact chambers is that the BOD, suspended solids, viruses and bacteria associated with the mixed sewage and storm water will be retained in the holding tanks for all flows up to their volumetric capacity, and subsequently discharged back into the dry weather flow interceptors. Thus for a design storm all of these pollutants will be held for treatment and not discharged to local bodies of water. However, the problem of sludge removal from holding tanks would be serious. The sludge must be removed from the tanks as soon as possible after a storm to prevent nuisance conditions from developing. This would require the provision of adequate ventilation facilities and facilities for sludge removal either by high-pressure flushing into the interceptors, mechanical sludge collection and pumping or by lowering loaders into the basins to scoop up the sludge and then lift it out through the roofs.

The chief disadvantage of surface holding tanks is that considerable area would be required for the sites of such tanks, many of which would be located in the most congested portions of the city. We estimate that approximately 640 acres would be required for the tank sites serving Boston only and about 670 acres for sites serving Boston and Brookline tributary areas. For the regional area encompassing the five municipalities of Boston, Brookline, Cambridge, Chelsea and Somerville the total holding tank site area of about 1,060 acres would be required. These areas are based upon an average liquid depth of about 10 ft, which would, in general, eliminate the need for pumping. Conceivably the depth of the tanks could be increased to reduce surface area. However, pumping would then be required and the problem of pumping the liquid from each tank would be present.

Since more land area would be required for holding tanks than for chlorination detention tanks, the disadvantages of holding tanks due to land requirements in Boston are therefore greater than for chlorination detention tanks.

A single surface holding tank or series of tanks to serve the Stony Brook system tributary to outlet No. 45 would require a tank surface area of approximately 80 acres. Total land area of perhaps 150 acres would be required for an adequate site or sites. Because of the large area required and the densely built-up nature of the area in the vicinity of Stony Brook, either an extensive area now occupied by valuable real estate would be required, or a single large holding tank alternatively would have to be placed in the Charles River Basin. Similarly, the holding tank to serve outlets now discharging into Fort Point Channel (Outlets No. 67, 218, 68, 69, 70, 72, 73, 219, 84 and 85) would require a total tank surface area of about 80 acres. The total site area would be provided either by acquiring much valuable real estate or utilizing much of Fort Point Channel.

Estimated Costs of Holding Tanks

The estimated costs of the surface holding tanks are shown in Table 17. Estimated construction costs include the costs of land for tank sites, combined flow conduits to tank sites and new separate sanitary sewers required in areas not proposed to be served by holding tanks. Tank site costs include the cost of land, building acquisition, and building demolition costs as applicable, and have been based upon estimates for such costs for recent real estate transactions in various parts of the city.

TABLE 17 ESTIMATED COSTS OF HOLDING TANKS AND AREAS SERVED

Item	Areas Served Boston	Boston and Brookline	Regional Area (5 Cities)
Estimated Construction Costs, Million Dollars			
Tank Sites	228.0	216.0	363.0
Holding Tanks	197.0	190.0	313.0
Conduits	18.0	18.0	29.0
Separation	7.0	6.0	10.0
TOTAL ESTIMATED CONSTRUCTION COST	450.0	430.0	715.0
Estimated Annual Operation and Maintenance Costs, Million Dollars	2.530	2.556	3.958
Tributary Area, Acres	10,700	10,300	17,000

As indicated in the discussion of holding tanks, land for this method, if it were available, could be obtained only at high cost. Such use of this land would in addition prevent it from being used for recreational, business or residential purposes.

We estimate that the construction costs for holding tanks would be about 430 million dollars for Boston alone, 450 million dollars for Boston and Brookline and 715 million dollars for the five-city regional area including Boston, Brookline, Cambridge, Chelsea, and Somerville, as shown on Table 17.

Estimated annual costs of operation and maintenance shown in this table include costs for labor, electric power and maintenance and repair. Estimated costs of maintenance and repair are based on 1.00% of construction costs for equipment, 0.50% for structures and 0.25% for conduits and separate sanitary sewers.

Construction of Deep Tunnel Plan

Description

The fourth alternative method for handling discharges of mixed sewage and storm water is to construct a system of deep rock storage tunnels with pumping station, ocean outfall and diffusers. This method is discussed in detail in Appendix F.

The tunnels would store and conduct the flows to a point where they can be pumped. It is essential, as a part of this method, that the tunnels be emptied as soon as possible following a storm to provide the available storage volume for the next storm.

The geologic formation of the City of Boston, discussed in Chapter II, lends itself to the construction of deep rock tunnels. The MDC has recently constructed smaller size deep rock tunnels as part of the metropolitan sewerage and water systems. In addition, extensive records on the rock beneath Boston are available as a result of innumerable construction projects and borings which have been undertaken in the city.

The areas served by a deep tunnel plan would be about 10,300 acres for Boston, 10,700 acres for Boston and Brookline, and 17,000 acres for the regional area of Boston, Brookline, Cambridge, Chelsea and Somerville. This method would eliminate all overflows from this entire area resulting from rainstorms. We consider that existing combined sewer areas located outside of the area served may be more economical to separate than to connect to the tunnel system.

As a result of our studies, it appears reasonable that a deep tunnel storage plan can be constructed that would handle the runoff resulting from a rainfall of 15-year frequency and 24 hour duration (total rainfall depth 5-in) and dispose of this runoff within a 2 day period without surcharging the tunnels. To dispose of the runoff over a longer period would entail a much greater increase in the cost of storage tunnels than could be compensated for by a decrease in the cost of the pumping station. If on the other hand, the tunnels are permitted to surcharge, a storm of about 8.40 inches in one day may be handled. Furthermore, for rainstorms in excess of 8.40 inches in 24 hours the pumps could discharge the whole flow through a short outfall.

The estimated cost of a deep tunnel storage plan is dependent in large measure on the cost to excavate rock. Our estimates have been based on the use of 33 ft diameter storage tunnels similar to those proposed in the Chicago study by Harza and Bauer. It was determined from our studies that required pumping capacities should be about 2,400 cfs at 300 to 350 ft total head with tunnels not surcharged and about 5,200 cfs at 200 ft with surcharge, with a tunnel storage volume equivalent to a minimum length of about 17.2 miles of such 33 ft diameter tunnels. A main pumping station would be located at Deer Island and have provisions for ventilation, control, screening and hypochlorination facilities.

The storage tunnels would consist of five radial tunnels, a central rock chamber beneath Columbus Park and one main or trunk tunnel extending to a pumping station located in a rock chamber at Deer Island. To conduct flows of mixed sewage and storm water to the deep storage tunnels, surface connections consisting of interception chambers and surface conduits, drop shafts either vertical or inclined, and transmission tunnels would be required.

It is not possible at the present time to consistently predict with accuracy the intensity, duration or volume of rainfall which will occur for any given storm. As a result it would not be possible to fully foresee the maximum pumping rate which may be required for a given storm. Therefore, it would probably be necessary to operate the pumps individually, following as closely as possible the storm development. This procedure would tend to minimize the possibility that the storm might develop so rapidly that the tunnels would become filled earlier than anticipated. For a storm of greater severity than 8.40 in of rain in 24 hours an additional short outfall would be required.

Our studies indicate that the most economical combination of pumping station and outfall size would include a single 20 ft diameter 45,000 foot long outfall with twin 14 ft diameter 5,800 foot long diffuser pipes. At a pumping rate of 2,400 cfs, the velocity in the outfall pipe would be about 7.5 fps, and with about 600 7-in diameter nozzles in the diffuser pipes 15 fps diffuser velocities would be achieved. With this pumping rate and a water depth of about 110 ft at the diffusers, an estimated minimum dilution ratio of about 200 parts of ocean water to 1 part of waste water would be achieved in the rising plume of waste water.

The determination of this dilution ratio does not consider the effect of ocean currents to provide additional mixing and dilution between the rising plume and shore. Further, the sewage is diluted to varying degrees with storm water in the tunnels and outfall before it enters the dispersion field. We, therefore, would expect dilution ratios to vary from 200 to 1 early in a storm to perhaps 6,000 to 1 during later periods with consequent reduction in the concentration of bacteria and viruses and other polluting substances of between 99.50 per cent and 99.98 per cent, even without chlorination, which is a much greater reduction than can be achieved by conventional "complete" treatment. Natural die-off of bacteria and viruses in ocean water has not been allowed for but should reduce the concentrations. In order to provide positive kill of bacteria and viruses, we propose a 30 ppm chlorine dose be applied year round. It is important to note that the prevailing wind directions are northwest and southwest, generally away from shore, such that in the event some material should float, it may be expected to pass out to sea.

Estimated Costs of the Deep Tunnel Plan

The estimated costs for various items included in the Deep Tunnel Plan are shown in Table 18. Total estimated construction costs are 300 million dollars for Boston, 310 million dollars for Boston and Brookline and 430 million dollars for the regional area of Boston, Brookline, Cambridge, Chelsea and Somerville.

Estimated annual costs for operation and maintenance include the cost of labor, sodium hypochlorite solution, electric power from commercial sources, and maintenance and repair. Electric power costs consist of demand and energy charges required primarily for pumping. Estimated maintenance and repair costs shown in Table 18 are based on 1.00% of construction costs for equipment, 0.50% for structures and 0.25% for conduits and separate sanitary sewers.

Conclusions

Estimated costs for the four alternative methods of handling discharges or overflows of mixed sewage and storm water from the regional area are presented in Table 19. From this table it may be seen that the estimated total cost for the proposed Deep Tunnel Plan is less than for the other three alternatives. Advantages and disadvantages of each alternative are discussed in Appendix F.

We propose that the City of Boston adopt the Deep Tunnel Plan alternative at the earliest possible date. Advantages of the Deep Tunnel Plan are as follows:

1. The Deep Tunnel Plan provides the best and most practical regional solution to the problem of handling mixed sewage and storm water and assures abatement of water pollution due to both sewage and surface runoff.
2. The Deep Tunnel Plan is adaptable to serve any conceivable development of Boston or the regional area in the future.
3. The Deep Tunnel Plan is the most economical means for eliminating overflows to the surrounding waters.
4. The estimated total cost of the Deep Tunnel Plan is less than for alternative methods including complete separation, and this plan may become relatively less expensive in the future as rock boring technology improves.
5. The Deep Tunnel Plan will occupy very little valuable land area.
6. Construction of the Deep Tunnel Plan will not cause interference with traffic or surface activities.
7. Construction of the Deep Tunnel Plan will permit the efficient draining of all areas that now flood during heavy rains and high tides.

TABLE 18 ESTIMATED COSTS OF THE DEEP TUNNEL PLAN AND AREAS SERVED

Item	Boston	Boston and Brookline	Regional Area (5 Cities)
	Areas Served		
Estimated Construction Costs, Million Dollars			
Deep Storage Tunnels (including Central Chamber and Drop Shafts)	140.0	145.0	213.0
Main Pumping Station (Deer Island)	32.0	33.0	39.0
Ocean Outfall and Diffusers	40.0	41.0	54.0
Surface Connections	19.0	20.0	26.0
Transmission Tunnels (including drop shafts)	63.0	64.0	88.0
Separation	6.0	7.0	10.0
TOTAL ESTIMATED CONSTRUCTION COST	300.0	310.0	430.0
Estimated Annual Operation and Maintenance Costs, Million Dollars	1.910	1.970	2.630
Tributary Area, Acres	10,300	10,700	17,000

TABLE 19

ESTIMATED COSTS OF ALTERNATIVE METHODS FOR THE REGIONAL AREA

	Estimated Costs, Million Dollars		
Method	Construction	Capitalized Operation and Maintenance*	Total
Complete Separation	550.0	34.0	584.0
Chlorination Detention Tanks	400.0	133.0	533.0
Holding Tanks	715.0	99.0	814.0
Deep Tunnel Plan	430.0	66.0	496.0

*At interest rate of 4.00%

NOTE: Costs do not include replacement of existing storm drains or combined sewers.

8. The Deep Tunnel Plan will provide the means for disposing of all polluted surface water and sewage well out to sea away from any inhabited areas. The ocean outfall will permit the safe discharge to sea of all treated or untreated waste water from Deer Island facilities.

9. Sections of the deep storage tunnels will parallel the MDC Boston Main Drainage Tunnel and have lower inverts to complement the existing MDC sewerage system.

10. The large quantity of rock excavated from the tunnels during construction will be available at low cost for fill in connection with the expansion of Logan International Airport, site development for the proposed 1975 Worlds Fair or other fill operations in and around Boston Harbor.

Until such time as the City makes a committment to adopt the proposed Deep Tunnel Plan, it should continue its present policy of complete separation of sanitary sewerage and storm drainage systems.

VIII IMPROVEMENTS TO EXISTING BOSTON SEWERAGE SYSTEM

Proposed Sanitary Sewers and Storm Conduits

New sanitary sewers and storm conduits are proposed wherever existing principal lines (described in Chapter III) are estimated to have inadequate capacity to carry estimated year 2020 peak design flows or have exhibited evidence of structural deterioration. It has not been possible to carry out photographic inspection of existing sewers and conduits, because of practically continuous surcharged conditions of the existing principal sewers such as the Boston Main and East Side Interceptors. Therefore, we have not included in the proposed construction programs the rehabilitation or relocation of those lines which are considered to be hydraulically adequate in capacity. We consider that many existing sewers and conduits which we estimate to have adequate hydraulic capacity are either now in poor condition or will be before the year 2020. Such conduits must then be rehabilitated or replaced as conditions dictate.

We have proposed the construction of sewers and conduits in new locations where required to fully serve the needs of the tributary areas and provide the most economic solutions as described below. Construction work included in the proposed Initial Construction Program is described in detail herein. Items of work proposed for inclusion in the Future Construction Program are generally described in less detail inasmuch as they should be of less urgent nature. All works proposed herein have been designed to function effectively in conjunction with the proposed Deep Tunnel Plan described in Chapter VII and in Appendix F of Vol. 2.

Profiles of sewers and interceptors proposed for construction in the recommended Initial Construction Program and the West Side Interceptor and upstream portions of the East Side Interceptor proposed for construction in the Future Construction Program, are presented below. It should be noted that wherever combined sewers are shown entering proposed interceptors and sewers on these profiles, we propose local sewer construction so that the combined sewers will either be abandoned or converted to use as sanitary sewers herein.

Estimated costs for rehabilitating outlets and appurtenant facilities are not included in the costs of proposed sewers and conduits but are presented separately.

The proposed construction programs are shown in plan on Fig. C, and the recommended Initial Construction Program is shown in greater detail in red on Fig. D. Both of these figures are appended to Vol. 1. Facilities included in each of the proposed construction programs, together with estimated construction costs, are summarized in Chapter IX. Subsurface data obtained from others and obtained from a soil boring program undertaken for this study are shown in Appendix G of Vol. 2.

Proposed Main Interceptor

The proposed Main Interceptor will follow a route completely different from that occupied by the existing Boston Main Interceptor, as shown on Fig. D. The existing Boston Main Interceptor connects to the existing West Side Interceptor at Huntington Avenue and Gainsborough Street, and extends down Camden Street, Washington Street, Massachusetts Avenue, Clapp Street, and Mt. Vernon Street to the existing Calf Pasture Pumping

Station, as described in Chapter III. The proposed interceptor is planned to begin at a proposed junction chamber at the extension of Union Park Street, where it will receive flow from both the proposed East Side Interceptor and the proposed Roxbury Canal Branch of the East Side Interceptor. In addition, a connection receiving dry weather flows from the existing high and low level dry weather connections to the existing East Side Interceptor at Union Park Street, will be constructed to the proposed junction chamber.

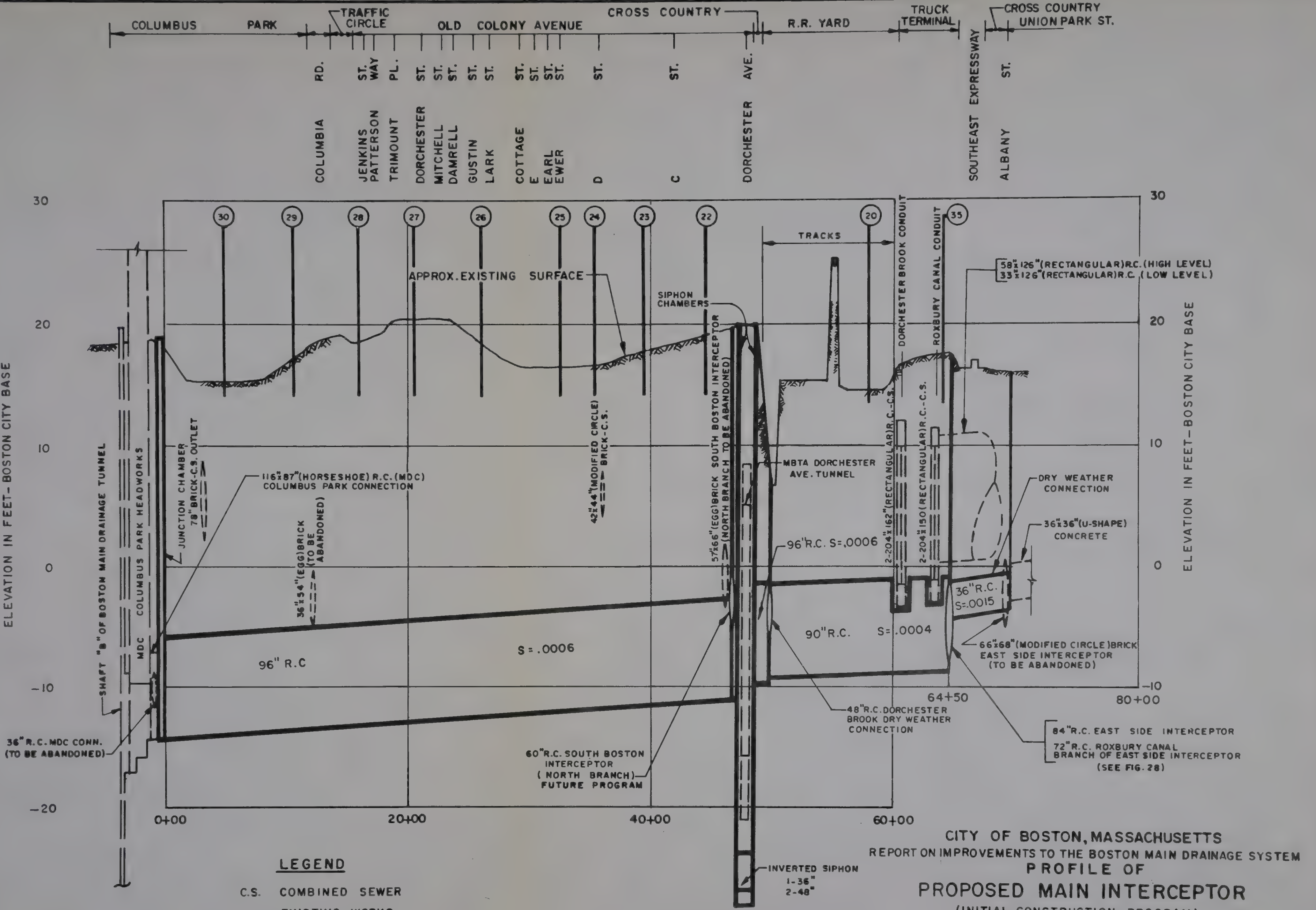
From the junction chamber, the proposed Main Interceptor will head eastward as a 90-in diameter pipe passing beneath the Roxbury Canal Conduit and Dorchester Brook Conduit as shown on the profile, Fig. 24. The crown of the proposed interceptor will be depressed where it crosses beneath these existing conduits. The interceptor will continue on through the New York, New Haven and Hartford Railroad yards as a 90-in diameter pipe. Within the yards, the proposed interceptor will be jacked beneath the tracks of the Old Colony Division and the Midland Division, which are now principal rail freight routes. It is expected that the proposed interceptor can be constructed through the railroad yards in open cut, except for the jacking operations beneath the tracks of these two divisions.

About 80 ft west of Dorchester Avenue a proposed 48-in diameter dry weather connection from the existing Dorchester Brook Conduit will enter the proposed Main Interceptor at a proposed junction chamber. A profile of this 48-in connection is shown on Fig. 25. Downstream from this junction chamber the proposed interceptor will be a 96-in diameter pipe.

The proposed interceptor then will enter an inverted siphon at Dorchester Avenue. This siphon is required to carry flows below the MBTA Dorchester Avenue Tunnel and will consist of three pipes located between the inlet and outlet chambers. Downstream from the siphon it will receive flow from the existing South Boston Interceptor (North Branch), and will turn down Old Colony Avenue, which was originally constructed as a railroad right-of-way. Below Dorchester Avenue, the proposed Main Interceptor will be a 96-in pipe, and open cut construction is considered suitable all the way to Columbus Park. Near Vinton Street at Columbia Road, the proposed interceptor will turn to the east and will cross beneath the South Boston Interceptor (South Branch) which will be abandoned in conjunction with the construction of the proposed South Boston Pollution Control Conduit as described hereinafter. The proposed interceptor then will traverse Columbus Park and enter a proposed junction chamber on the existing MDC Columbus Park Connection.

The total area tributary to the proposed Main Interceptor, including the areas tributary to the proposed Massachusetts Avenue Sewers, East Side Interceptor, and Roxbury Canal Branch of the East Side Interceptor, is estimated to be about 3,490 acres. The estimated construction cost of the proposed Main Interceptor including an allowance for engineering and contingencies is 7,100,000 dollars.

Two alternative routes for the proposed Main Interceptor were considered prior to the selection of the Old Colony Avenue route described above. These two alternative routes were (1) along the route of the existing Boston Main Interceptor as described above, and (2) the Southampton Street route from Massachusetts Avenue at Albany Street to the existing MDC Columbus Park Connection


COLUMBUS PARK
TRAFFIC CIRCLE
OLD COLONY AVENUE
CROSS COUNTRY
R.R. YARD
TRUCK TERMINAL
CROSS COUNTRY
UNION PARK ST.
COLUMBIA RD.
JENKINS ST.
PATTERSON WAY
TRIMOUNT PL.
DORCHESTER ST.
MITCHELL ST.
DAMRELL ST.
GUSTIN ST.
LARK ST.
COTTAGE ST.
E ST.
EARL ST.
EWER ST.
D ST.
C ST.
DORCHESTER AVE.
SOUTHEAST EXPRESSWAY
ALBANY ST.
30
20
10
0
-10
-20
ELEVATION IN FEET - BOSTON CITY BASE
30
29
28
27
26
25
24
23
22
20
35
TRACKS
APPROX. EXISTING SURFACE
SIPHON CHAMBERS
DORCHESTER BROOK CONDUIT
ROXBURY CANAL CONDUIT
58"x126" (RECTANGULAR) R.C. (HIGH LEVEL)
33"x126" (RECTANGULAR) R.C. (LOW LEVEL)
SHAFT "B" OF BOSTON MAIN DRAINAGE TUNNEL
MDC
COLUMBUS PARK HEADWORKS
JUNCTION CHAMBER
78" BRICK-C.S. OUTLET
116"x87" (HORSESHOE) R.C. (MDC) COLUMBUS PARK CONNECTION
36"x54" (EGG) BRICK (TO BE ABANDONED)
42"x44" (MODIFIED CIRCLE) BRICK-C.S.
57"x66" (EGG) BRICK SOUTH BOSTON INTERCEPTOR (NORTH BRANCH TO BE ABANDONED)
MBTA DORCHESTER AVE. TUNNEL
96" R.C. S=.0006
2-204"x162" (RECTANGULAR) R.C.-C.S.
2-204"x150 (RECTANGULAR) R.C.-C.S.
DRY WEATHER CONNECTION
36"x36" (U-SHAPE) CONCRETE
36" R.C. S=.0015
90" R.C.
S=.0004
66"x68" (MODIFIED CIRCLE) BRICK EAST SIDE INTERCEPTOR (TO BE ABANDONED)
96" R.C
S = .0006
36" R.C. MDC CONN. (TO BE ABANDONED)
60" R.C. SOUTH BOSTON INTERCEPTOR (NORTH BRANCH) FUTURE PROGRAM
48" R.C. DORCHESTER BROOK DRY WEATHER CONNECTION
84" R.C. EAST SIDE INTERCEPTOR
72" R.C. ROXBURY CANAL BRANCH OF EAST SIDE INTERCEPTOR (SEE FIG. 28)
INVERTED SIPHON 1-36" 2-48"
0+00
20+00
40+00
60+00
64+50
80+00

LEGEND

C.S. COMBINED SEWER

— — — EXISTING WORKS

⑳ CDM BORING NUMBER

Notes:

1. For Boring Locations See Plan Fig. D
2. For Boring Logs See Appendix G.

CITY OF BOSTON, MASSACHUSETTS
REPORT ON IMPROVEMENTS TO THE BOSTON MAIN DRAINAGE SYSTEM

PROFILE OF PROPOSED MAIN INTERCEPTOR

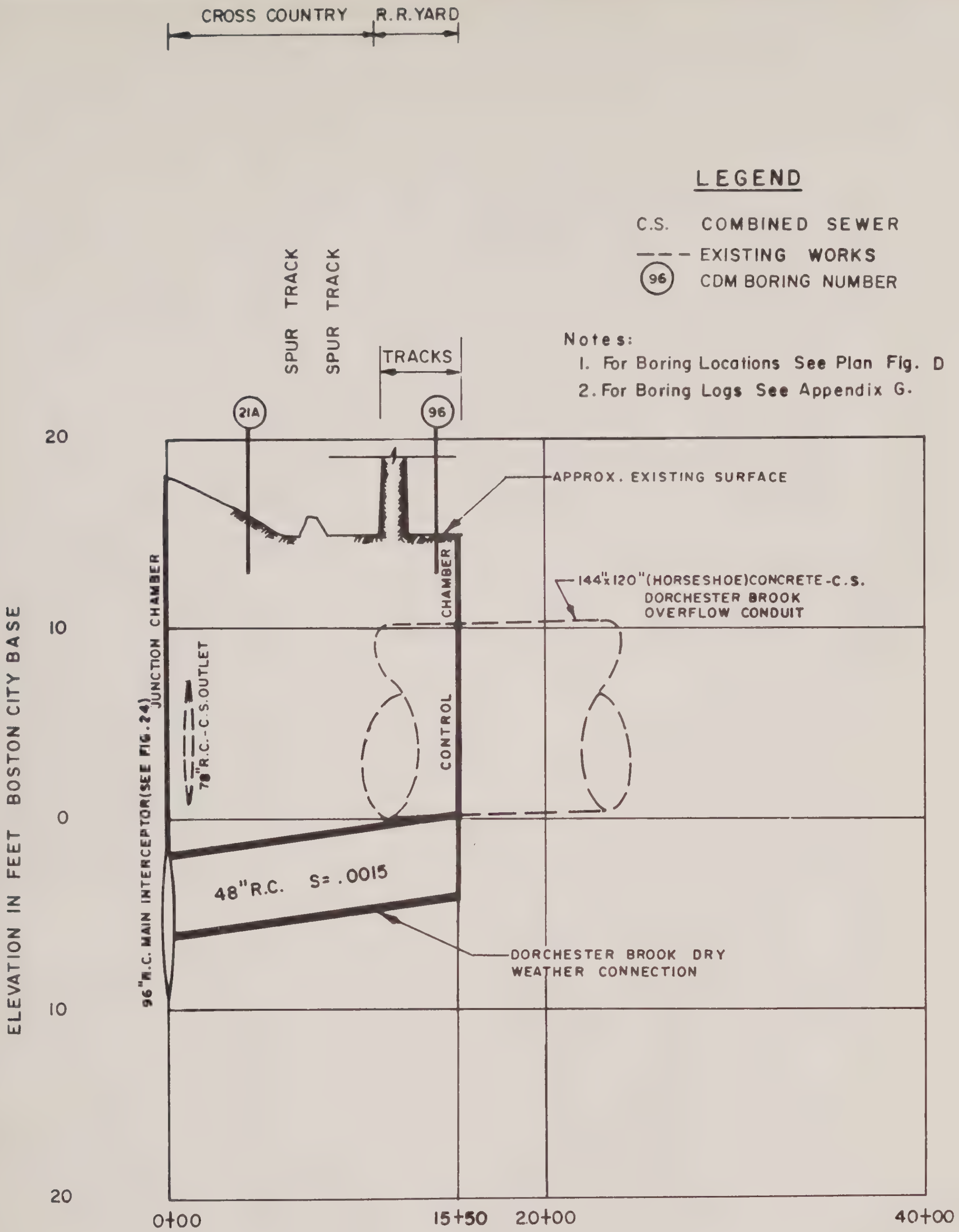
(INITIAL CONSTRUCTION PROGRAM)

Camp, Dresser & McKee
Consulting Engineers
Boston, Mass.

SCALES: AS INDICATED

SEPTEMBER, 1967

FIG. 24



Notes:
1. For Boring Locations See Plan Fig. D
2. For Boring Logs See Appendix G.

CITY OF BOSTON, MASSACHUSETTS
REPORT ON IMPROVEMENTS TO THE BOSTON MAIN DRAINAGE SYSTEM
PROFILE OF
PROPOSED DORCHESTER BROOK DRY WEATHER CONNECTION
(INITIAL CONSTRUCTION PROGRAM)

Camp, Dresser & McKee
Consulting Engineers
Boston, Mass.

SCALE: AS INDICATED

SEPTEMBER, 1967

FIG. 25

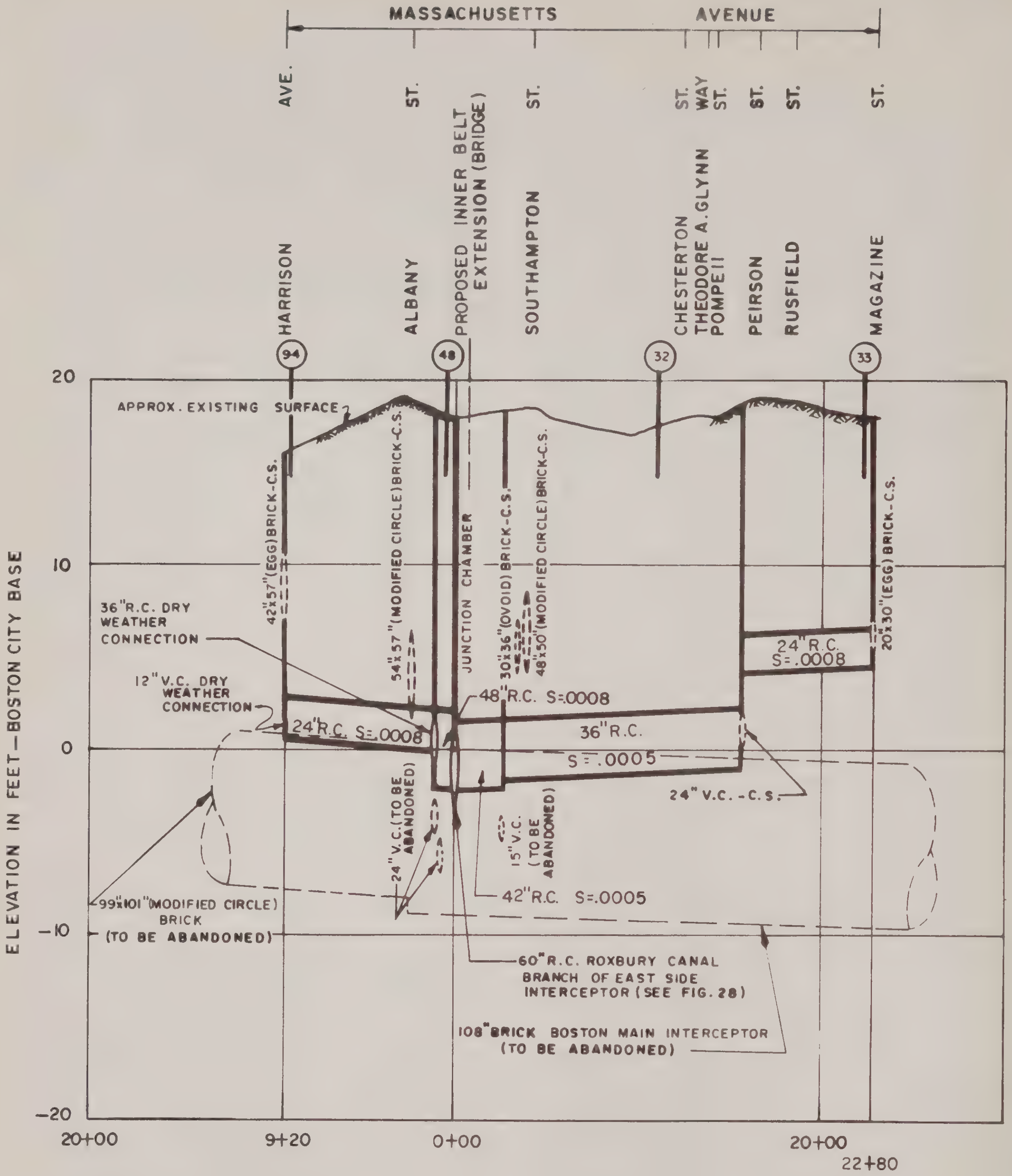
at Mt. Vernon Street. Each of these alternative routes would require the construction of a large diameter sewer for much longer distances than does the proposed route. The selected route is the most direct feasible route for carrying flows from the East Side Interceptor to Columbus Park for disposal. Since the types of difficulties encountered on each of the routes would be similar, the shorter route is the more economical.

Additional proposed sewer construction which is required in conjunction with the construction of the proposed Main Interceptor includes:

1. A 12-in diameter dry weather connection from a proposed rehabilitated regulator structure in Harrison Avenue to Massachusetts Avenue, a 24-in diameter pipe in Massachusetts Avenue from Harrison Avenue to a point downstream of Albany Street where a proposed dry weather connection from the existing common sewer will enter, and a 48-in diameter pipe from that connection will enter, and a 48-in diameter pipe from that connection to a proposed junction chamber at the Roxbury Canal Branch of the East Side Interceptor as shown on Fig. 26. The estimated construction cost of this portion of the Massachusetts Avenue sewers including an allowance for engineering and contingencies is 210,000 dollars.

2. A 24-in diameter pipe from the existing 20-in x 30-in common sewer at Magazine Street, along Massachusetts Avenue to near T.A. Glynn Way at the New England Provision Company in New Market Square (formerly Burnham Street) where it will receive dry weather flows from another existing common sewer. Storm flows that now reach the existing Boston Main Interceptor through these common sewers will be diverted through proposed connections to existing storm conduits serving the area. Downstream from near T.A. Glynn Way, the sewer will be 36-in. in diameter, pass beneath the proposed Inner Belt highway extension as a 42-in pipe and discharge to a junction chamber on the Roxbury Canal Branch of the East Side Interceptor. A profile of these proposed Massachusetts Avenue Sewers is shown on Fig. 26. The estimated construction cost of this portion of the proposed Massachusetts Avenue Sewers including an allowance for engineering and contingencies is 540,000 dollars.

3. An 18-in diameter pipe in Massachusetts Avenue at Shirley Street which will receive dry weather flow from an existing 24-in x 44-in common sewer as shown on Fig. 27. Storm drains now discharging to the common sewer in Shetland Street will be connected to the existing combined sewer in Norfolk Avenue. Flow from Shirley Street reaches Massachusetts Avenue at too low an elevation to reach either the proposed sewer at Magazine Street described above or the existing Dorchester Brook Sewer. When the sewer enters Clapp Street, it will become a 27-in pipe, and in the vicinity of Enterprise Street the proposed sewer will be constructed within the existing Boston Main Interceptor tunnel. Existing access structures will be reconstructed. Beneath Mt. Vernon Street


MASSACHUSETTS AVENUE
HARRISON AVE.
ALBANY ST.
PROPOSED INNER BELT EXTENSION (BRIDGE)
SOUTHAMPTON ST.
CHESTERTON ST.
THEODORE A. GLYNN WAY
POMPEII ST.
PEIRSON ST.
RUSFIELD ST.
MAGAZINE ST.
94
48
32
33
20
10
0
-10
-20
ELEVATION IN FEET—BOSTON CITY BASE
APPROX. EXISTING SURFACE
42"x57" (EGG) BRICK-C.S.
54"x57" (MODIFIED CIRCLE) BRICK-C.S.
JUNCTION CHAMBER
30"x36" (OVOID) BRICK-C.S.
48"x50" (MODIFIED CIRCLE) BRICK-C.S.
20"x30" (EGG) BRICK-C.S.
36"R.C. DRY WEATHER CONNECTION
12"V.C. DRY WEATHER CONNECTION
24"R.C. S=.0008
48"R.C. S=.0008
36"R.C.
S=.0005
24"R.C. S=.0008
24"V.C.-C.S.
24"V.C. (TO BE ABANDONED)
15"V.C. (TO BE ABANDONED)
42"R.C. S=.0005
99"x101" (MODIFIED CIRCLE) BRICK (TO BE ABANDONED)
60"R.C. ROXBURY CANAL BRANCH OF EAST SIDE INTERCEPTOR (SEE FIG. 28)
108" BRICK BOSTON MAIN INTERCEPTOR (TO BE ABANDONED)
20+00
9+20
0+00
20+00
22+80

LEGEND

C.S. COMBINED SEWER
– – – – EXISTING WORKS
(33) CDM BORING NUMBER

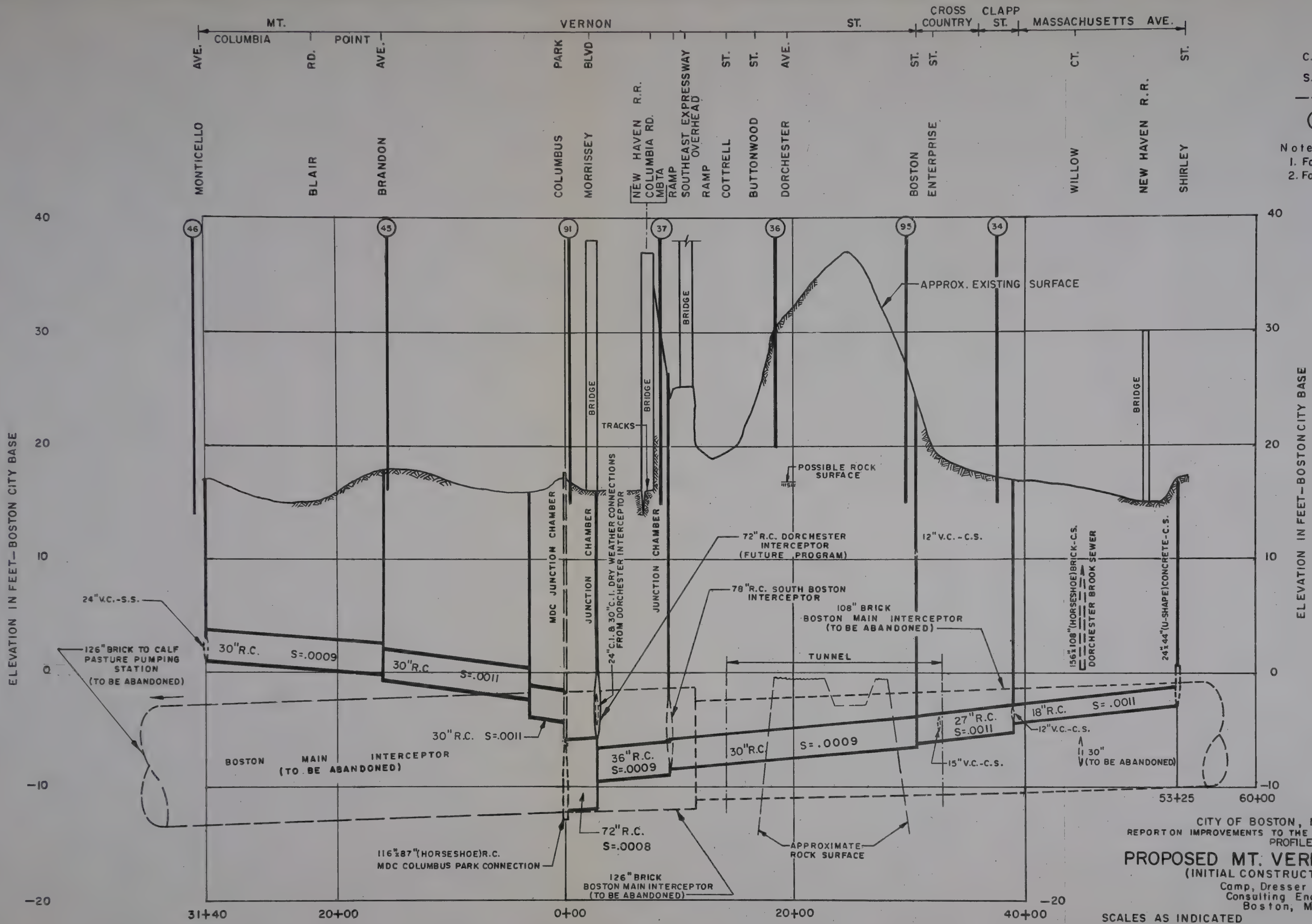
Notes:
1. For Boring Locations See Plan Fig. D
2. For Boring Logs See Appendix G.

CITY OF BOSTON, MASSACHUSETTS
REPORT ON IMPROVEMENTS TO THE BOSTON MAIN DRAINAGE SYSTEM
PROFILE OF
PROPOSED MASSACHUSETTS AVENUE SEWERS
(INITIAL CONSTRUCTION PROGRAM)

Camp, Dresser & McKee
Consulting Engineers
Boston, Mass.

SCALES: AS INDICATED
SEPTEMBER, 1967

FIG. 26



LEGEND

C.S. COMBINED SEWER
S.S. SANITARY SEWER
——— EXISTING WORKS
(36) CDM BORING NUMBER

Notes:
1. For Boring Locations See Plan Fig. D
2. For Boring Logs See Appendix G.

CITY OF BOSTON, MASSACHUSETTS
REPORT ON IMPROVEMENTS TO THE BOSTON MAIN DRAINAGE SYSTEM
PROFILE OF

PROPOSED MT. VERNON ST. SEWERS

(INITIAL CONSTRUCTION PROGRAM)
Camp, Dresser & McKee
Consulting Engineers
Boston, Mass.

SCALES AS INDICATED

SEPTEMBER, 1967

FIG. 27

at Boston Street, the proposed sewer will become a 30-in pipe, and at a proposed junction chamber at the South Boston Interceptor connection it will become a 36-in pipe and remain within the existing interceptor. At Morrisey Boulevard another proposed junction chamber will be constructed to receive dry weather flow from the Dorchester Interceptor, at which point the sewer will become 72-in. in diameter. This 72-in sewer will enter the existing MDC junction chamber at Columbus Park. The weir located within this junction chamber will be removed inasmuch as no storm flows will then pass through the chamber. The estimated construction cost of this portion of the proposed Mt. Vernon Street sewers as described above including engineering and contingencies is 2,180,000 dollars.

4. A 30-in diameter sewer in Mt. Vernon Street which will receive dry weather flow from the Columbia Point housing project and carry it to the existing MDC junction chamber at Columbus Park as shown on Fig. 27. The estimated construction cost of this portion of the proposed Mt. Vernon Street sewers including engineering and contingencies is 700,000 dollars.

5. An overflow control chamber which will be constructed immediately upstream from the existing outlet to the portion of the existing Dorchester Brook Conduit which was built in 1953. All storm flows will pass through sluice gates before leaving this chamber and into the recently constructed downstream portion of the existing Dorchester Brook Conduit. Provisions will be made in the chamber such that when the proposed deep tunnels (Chapter VII and Appendix F) are constructed, storm flows will be diverted to the tunnel through a proposed drop shaft to be located about 400 ft north of the proposed control chamber.

   The proposed control chamber will divert flows equivalent to estimated peak tributary dry weather flows through the proposed 48-in diameter Dorchester Brook Dry Weather Connection shown on Fig. 25. This connection will be jacked beneath tracks of the Old Colony Division and enter the proposed Main Interceptor at a proposed junction chamber located about 80 feet west of Dorchester Avenue. The estimated construction cost of the proposed control chamber and dry weather connection including engineering and contingencies is 240,000 dollars.

Alternative locations for connections receiving dry weather flows from the Dorchester Brook area were considered; (1) from the proposed control chamber to the existing South Boston Interceptor (North Branch) at Damrell Street, and (2) from the existing regulator at Massachusetts Avenue to the proposed Mt. Vernon Street Sewer, plus a connection from the proposed junction chamber either to Damrell Street or to the proposed Main Interceptor which would serve the developing area of the filled-in South Bay. These alternatives would result in either larger required pipe sizes for the proposed Mt. Vernon Street sewers or the replacement for the existing South Boston Interceptor (Future Construction Program) for longer lengths than the proposed route.

The proposed route of the Dorchester Brook Dry Weather Connection, therefore, provides the most economical and practical route and will, in addition, provide the most reasonable method of handling dry weather flows from this area.

Upon completion of this proposed construction, the existing tidegates, regulator and the dry weather connection from the Dorchester Brook Sewer to the Boston Main Interceptor at Massachusetts Avenue will be abandoned as described in Chapter IX.

Certain portions of the existing Boston Main Interceptor route may be utilized to facilitate construction of proposed sewers as discussed above. Functionally, however, the entire existing Boston Main Interceptor will be abandoned, except for the portion between Huntington and Tremont Streets which must be kept in service until the proposed West Side Interceptor is constructed as described hereinafter. In addition, the South Boston Interceptor (North Branch), between Old Colony Avenue and D Street will be abandoned.

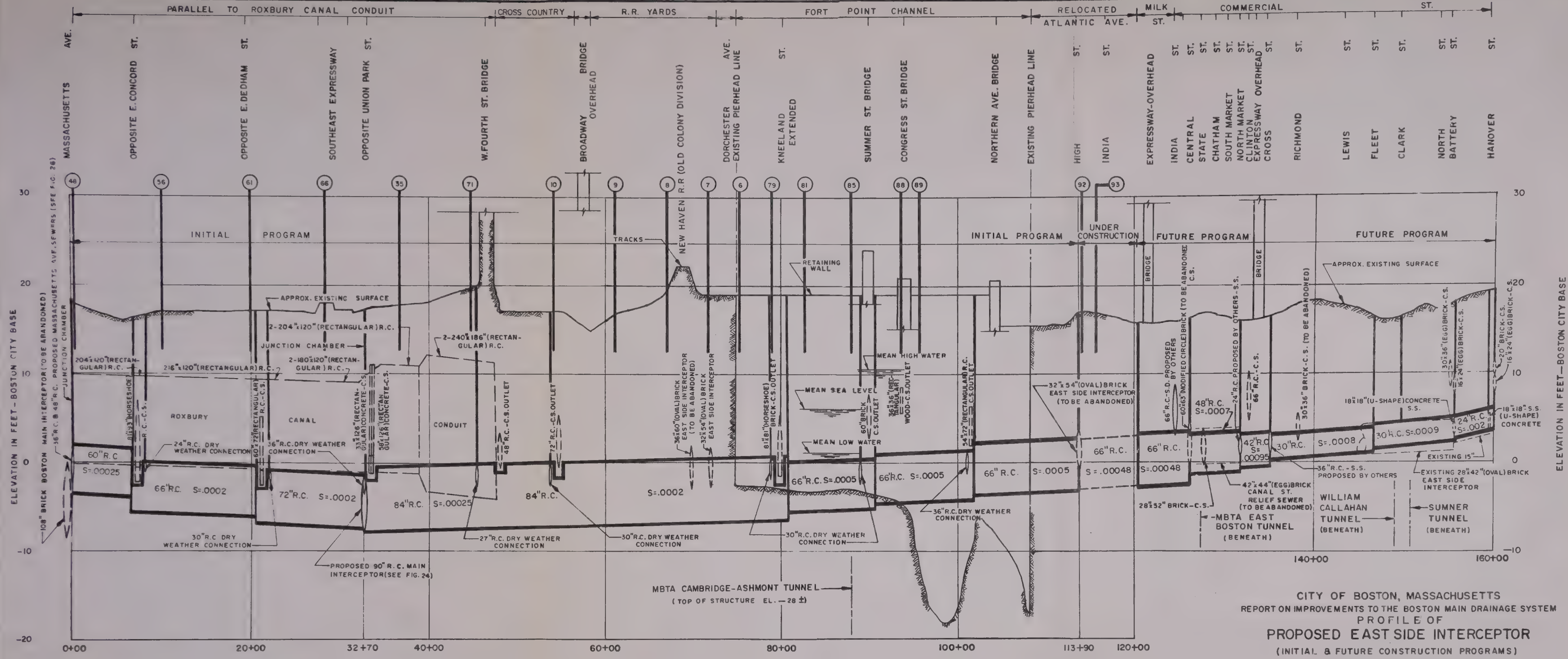
Existing sewers to be abandoned will be broken in and/or filled with compacted sand and gravel or other suitable material. It will, of course, be necessary to divert sewage flows away from such existing sewers prior to filling and compaction and during construction of proposed sewers in the existing sewer locations. Estimated costs for this work are included in the costs presented above.

Proposed East Side Interceptor

The profile of the proposed East Side Interceptor is shown on Fig. 28.

We propose that a new intercepting sewer be constructed along the route of the existing East Side Interceptor in Commercial Street from its upper end at Hanover Street to Fleet Street to replace the existing interceptor. Should future inspection reveal that the structural condition of the existing interceptor between Battery Street and Fleet Street is sound, rehabilitation should be considered. The size of the proposed interceptor in this reach is 24-in from Hanover Street to Battery Street and 30-in below Battery Street. It will receive dry weather flow at its upper end from a proposed overflow control chamber replacing an existing regulator discharging overflows to Outlet No. 60 below Hanover Street, and will receive dry weather flows from overflow control chambers at Battery Street and Clark Street as proposed by consultants to the Boston Redevelopment Authority on the Downtown Waterfront-Faneuil Hall Urban Renewal Project.

Between Fleet Street and High Street, the proposed interceptor will follow the route proposed by the consultants to the BRA which is via Commercial Street, McKinley Square and Milk Street. At Fleet Street an overflow control chamber will be constructed to discharge dry weather flow to the proposed East Side Interceptor which will be relocated to extend down Commercial Street to Cross Street as a 30-in diameter pipe. At Cross Street, flows from a sanitary sewer proposed in Cross Street by others to serve the North End and flows from a proposed dry weather connection from a proposed overflow control chamber on the existing Canal Street Relief Sewer will enter the proposed interceptor. Sections of this relief sewer which have not been recently reconstructed in conjunction with construction of the Central Artery should be replaced with conduits of adequate capacity. A storm conduit in Washington Street North is currently under consideration which would reduce flows tributary to the


PARALLEL TO ROXBURY CANAL CONDUIT
CROSS COUNTRY
R.R. YARDS
FORT POINT CHANNEL
RELOCATED ATLANTIC AVE.
MILK ST.
COMMERCIAL ST.
MASSACHUSETTS AVE.
OPPOSITE E. CONCORD ST.
OPPOSITE E. DEDHAM ST.
SOUTHEAST EXPRESSWAY
OPPOSITE UNION PARK ST.
W. FOURTH ST. BRIDGE
BROADWAY BRIDGE OVERHEAD
NEW HAVEN R.R (OLD COLONY DIVISION)
DORCHESTER AVE.
EXISTING PIERHEAD LINE
KNEELAND ST. EXTENDED
SUMMER ST. BRIDGE
CONGRESS ST. BRIDGE
NORTHERN AVE. BRIDGE
EXISTING PIERHEAD LINE
HIGH ST.
INDIA ST.
EXPRESSWAY-OVERHEAD
INDIA ST.
CENTRAL ST.
STATE ST.
CHATHAM ST.
SOUTH MARKET ST.
NORTH MARKET ST.
CLINTON ST.
EXPRESSWAY OVERHEAD
CROSS ST.
RICHMOND ST.
LEWIS ST.
FLEET ST.
CLARK ST.
NORTH ST.
BATTERY ST.
HANOVER ST.
48
56
61
66
35
71
10
9
8
7
6
79
81
85
88
89
92
93
INITIAL PROGRAM
INITIAL PROGRAM
UNDER CONSTRUCTION
FUTURE PROGRAM
FUTURE PROGRAM
ELEVATION IN FEET - BOSTON CITY BASE
30
20
10
0
-10
-20
JUNCTION CHAMBER
36"R.C. & 48"R.C. PROPOSED MASSACHUSETTS AVE. SEWERS (SEE FIG. 26)
108" BRICK BOSTON MAIN INTERCEPTOR (TO BE ABANDONED)
APPROX. EXISTING SURFACE
2-204"x120"(RECTANGULAR) R.C.
JUNCTION CHAMBER
2-180"x120"(RECTANGULAR) R.C.
2-240"x186"(RECTANGULAR) R.C.
204"x120"(RECTANGULAR) R.C.
216"x120"(RECTANGULAR) R.C.
81"x93"(HORSESHOE)
R.C.-C.S.
ROXBURY
CANAL
CONDUIT
60"x72"(RECTANGULAR) R.C.-C.S.
33"x126"(RECTANGULAR) CONCRETE-C.S.
36"x126"(RECTANGULAR) CONCRETE-C.S.
48"R.C.-C.S. OUTLET
72"R.C.-C.S. OUTLET
24"R.C. DRY WEATHER CONNECTION
36"R.C. DRY WEATHER CONNECTION
60"R.C
S=.00025
66"R.C. S=.0002
72"R.C. S=.0002
84"R.C. S=.00025
84"R.C.
S=.0002
30"R.C DRY WEATHER CONNECTION
PROPOSED 90"R.C. MAIN INTERCEPTOR (SEE FIG. 24)
27"R.C. DRY WEATHER CONNECTION
30"R.C. DRY WEATHER CONNECTION
TRACKS
36"x60"(OVAL) BRICK EAST SIDE INTERCEPTOR (TO BE ABANDONED)
32"x54"(OVAL) BRICK EAST SIDE INTERCEPTOR
RETAINING WALL
MEAN HIGH WATER
MEAN SEA LEVEL
MEAN LOW WATER
81"x81"(HORSESHOE) BRICK-C.S. OUTLET
60"BRICK C.S. OUTLET
36"x36"(RECTANGULAR) WOOD-C.S. OUTLET
54"x72"(RECTANGULAR) R.C. C.S. OUTLET
66"R.C. S=.0005
66"R.C. S=.0005
66"R.C.
S=.0005
S=.00048
30"R.C. DRY WEATHER CONNECTION
36"R.C. DRY WEATHER CONNECTION
MBTA CAMBRIDGE-ASHMONT TUNNEL
(TOP OF STRUCTURE EL. -28 ±)
32"x54"(OVAL) BRICK EAST SIDE INTERCEPTOR (TO BE ABANDONED)
BRIDGE
66"R.C.-S.D. PROPOSED BY OTHERS
60"x63"(MODIFIED CIRCLE) BRICK (TO BE ABANDONED) C.S.
48"R.C. S=.0007
24"R.C. PROPOSED BY OTHERS-S.S.
66"R.C.-C.S.
BRIDGE
66"R.C.
S=.00048
42"R.C S=.00095
30"R.C.
S=.0008
30"R.C. S=.0009
24"R.C. S=.002
28"x52" BRICK-C.S.
42"x44"(EGG) BRICK CANAL ST. RELIEF SEWER (TO BE ABANDONED)
MBTA EAST BOSTON TUNNEL (BENEATH)
30"x36"BRICK-C.S. (TO BE ABANDONED)
APPROX. EXISTING SURFACE
18"x18"(U-SHAPE) CONCRETE-S.S.
30"x36"(EGG) BRICK-C.S.
16"x24"(EGG) BRICK-C.S.
20"BRICK-C.S.
16"x24"(EGG) BRICK-C.S.
18"x18" S.S. (U-SHAPE) CONCRETE
EXISTING 15"
36"R.C.-S.S. PROPOSED BY OTHERS
EXISTING 28"x42"(OVAL) BRICK EAST SIDE INTERCEPTOR
WILLIAM CALLAHAN TUNNEL (BENEATH)
SUMNER TUNNEL (BENEATH)
0+00
20+00
32+70
40+00
60+00
80+00
100+00
113+90
120+00
140+00
160+00

CITY OF BOSTON, MASSACHUSETTS

REPORT ON IMPROVEMENTS TO THE BOSTON MAIN DRAINAGE SYSTEM

PROFILE OF

PROPOSED EAST SIDE INTERCEPTOR

(INITIAL & FUTURE CONSTRUCTION PROGRAMS)

Camp, Dresser & McKee
Consulting Engineers
Boston, Mass.

SCALES AS INDICATED

SEPTEMBER, 1967

FIG. 28

Notes:
1. For Boring Locations See Plan Fig. D
2. For Boring Logs See Appendix G.

LEGEND

C.S. COMBINED SEWER
S.S. SANITARY SEWER
S.D. STORM DRAIN
---- EXISTING WORKS
(66) CDM BORING NUMBER

relief sewer. Between Cross Street and North Market Street, the proposed interceptor will pass beneath the Central Artery (Fitzgerald Expressway) as a 42-in diameter pipe.

At North Market Street, a sanitary sewer to serve the Government Center area will enter the interceptor in Commercial Street. From North Market Street to Central Street at McKinley Square, the proposed interceptor will be a 48-in diameter pipe. At State Street, an existing combined sewer which will become a separate sanitary sewer as proposed by others, will connect to the proposed interceptor. At Milk Street and India Street, an overflow control chamber will be constructed to divert dry weather flow from tributary portions of the Central Business District and Government Center to the proposed interceptor. The principal storm drain for this area is proposed by others to pass over the proposed interceptor at Milk Street near India Street and to pass down Milk Street to the existing Central Street outlet (Outlet No. 66).

Downstream from Central Street the proposed East Side Interceptor will be a 66-in diameter pipe, making a right angle bend to the east in Milk Street and will pass beneath the Central Artery before entering Relocated Atlantic Avenue. At Relocated Atlantic Avenue and Milk Street, a local sanitary sewer proposed by others to be constructed in Relocated Atlantic Avenue will enter the proposed interceptor, which will serve areas north of Milk Street and east of Relocated Atlantic Avenue, and another sanitary sewer proposed by others, serving Central Wharf, site of the New England Aquarium, will also enter the proposed interceptor.

The proposed interceptor will then make a right angle bend to the south and enter the southbound lane of Relocated Atlantic Avenue as a 66-in diameter pipe. The interceptor will proceed along Relocated Atlantic Avenue to the vicinity of High Street where it will enter the proposed Dorchester Avenue Extension. Between Milk Street and a temporary connection to the existing East Side Interceptor in Atlantic Avenue, the interceptor in Relocated Atlantic Avenue is now under construction as shown on Fig. 28.

Construction will be in open cut upstream from High Street, and an allowance for piles is included in our estimates. Considerable utility relocation, rail spur track interruption, and subsurface problems with water handling, old piles, walls, foundations and roads are expected. Downstream from High Street construction is proposed as part of the Initial Construction Program.

At Rowe's Wharf, near the foot of High Street, the proposed East Side Interceptor will leave Relocated Atlantic Avenue and enter Fort Point Channel passing to the harbor side of the Assessors Stores Building along the planned Dorchester Avenue relocation route. We propose that the pipe be supported on piles. The proposed Dorchester Avenue relocation reportedly may be constructed either as an embankment or a viaduct. The pipe will pass down the north side of Fort Point Channel within the proposed relocation route as a 66-in diameter pipe, pass beneath the Northern Avenue Bridge, and receive flow from the proposed dry weather connection from the Oliver Street regulator (Outlet No. 218). At the proposed dry weather connection from the Kneeland Street regulator, the proposed interceptor will increase to 84-in diameter. The interceptor will have a deformed section where it crosses beneath the existing outlet from Kneeland Street (Outlet No. 70). It will leave Fort Point Channel immediately upstream of the Dorchester Avenue Bridge.

The proposed interceptor in Fort Point Channel is proposed to be constructed on piles at this time. If Dorchester Avenue is reconstructed on fill consideration should be given to construction of the proposed East Side Interceptor concurrently. During construction of the proposed interceptor in Fort Point Channel, precautions must be taken to assure the integrity and safety of the existing MBTA Cambridge-Ashmont subway tunnel, and an allowance for this has been made in our estimates.

The BRA is considering the feasibility of completely filling in the remaining portions of Fort Point Channel, southwest of Northern Avenue and the alternative of improving the quality of the water of Fort Point Channel to the point where it would become a aesthetic benefit to the community.

There is also under consideration at this time a proposed extension of the Massachusetts Turnpike from its present terminus at the interchange west of Dorchester Avenue via tunnel under Fort Point Channel and Boston Harbor to East Boston. If the construction of this extension is undertaken before the construction of the proposed East Side Interceptor, provisions should be made at that time for future construction of the proposed interceptor.

Upstream of the Dorchester Avenue Bridge, the proposed 84-in interceptor will pass into the New Haven Railroad yard in open cut and on piles and cross the route of the existing East Side Interceptor which will be abandoned. It will pass beneath a principal passenger railroad track where jacking will be required, and thence along the west side of Fort Point Channel beneath the Broadway Bridge and the West Fourth Street Bridge approach. We consider that the interceptor will be jacked beneath the West Fourth Street Bridge approach if the bridge is in service when the interceptor is constructed.

Where the proposed interceptor crosses beneath the existing combined sewer outlets between the Broadway Bridge and West Fourth Street (Outlets No. 72 and 73 respectively), it will have its crown depressed. Between West Fourth Street and the proposed Main Interceptor, including the portion in the proposed South End-Flower Mart area, the proposed East Side Interceptor will be parallel to, and within about 30 feet west of the existing Roxbury Canal Conduit in open cut on piles. The interceptor will have a depressed crown where it passes beneath the two Union Park Street outlets and discharge to the proposed junction chamber as an 84-in pipe.

The total estimated area tributary to the East Side Interceptor as described above is about 650 acres. The estimated construction cost of the East Side Interceptor from Hanover Street to Union Park Street, including engineering and contingencies is 9,100,000 dollars. The estimated cost of that portion downstream from Atlantic Avenue (High Street) is 7,400,000 dollars.

At Massachusetts Avenue, near City Hospital, a junction chamber will be constructed on the proposed Roxbury Canal Branch of the East Side Interceptor to receive dry weather flows from the proposed Massachusetts Avenue sewers as shown on Fig. 26 and from a rehabilitated regulator in Massachusetts Avenue. At this point, the proposed branch interceptor will be a 60-in diameter pipe. The route of the proposed Roxbury Canal Branch interceptor will be parallel to and within about 30 feet west of the existing Roxbury Canal Conduit down to its junction with the proposed Main Interceptor. The proposed interceptor will have a deformed section where it crosses beneath the existing outlet from East Concord Street to the existing Roxbury Canal Conduit. At the proposed East

Concord Street dry weather connection, the proposed interceptor will increase in size to a 66-in diameter pipe.

The proposed interceptor will have a deformed section where it crosses beneath the existing outlet from East Dedham Street to the existing Roxbury Canal Conduit. At the proposed East Dedham Street dry weather connection, the interceptor will increase from 66-in to 72-in diameter pipe. The interceptor will then pass beneath the Southeast Expressway which at this point is located slightly above the prevailing grade in the area. The pipe will be jacked beneath the highway. The proposed East Side Interceptor, the proposed Roxbury Canal Branch of the East Side Interceptor, and the proposed dry weather flow connection for Union Park Street will discharge to the proposed junction chamber adjacent to the two existing Union Park Street outlets and into the proposed Main Interceptor described above. The proposed junction chamber will be located between the Southeast Expressway and the Roxbury Canal Conduit. The total estimated area tributary to the Roxbury Canal Branch Interceptor is about 660 acres, and the estimated construction cost including engineering and contingencies is 3,880,000 dollars.

Existing regulators, tide gates, and outlets will be rehabilitated or reconstructed as described hereinafter, and proposed dry weather connections from rehabilitated or rebuilt chambers will be constructed as required and as shown on Fig. D, appended to this volume. The existing Union Park Street Pumping Station will be completely rehabilitated to modernize its facilities and provide the capacity required to pass storm flows from low-lying tributary areas to the Roxbury Canal Conduit until such time as the proposed Deep Tunnel Plan is constructed, at which time it may be abandoned.

Consultants to the BRA on the South End Urban Renewal Project have recommended rehabilitation of the Union Park Street Pumping Station in lieu of constructing a new station and are currently studying detailed improvements. In addition, construction contracts for rehabilitation and construction of tide gate facilities in the South End area reportedly are now being prepared.

During the course of our studies of the East Side Interceptor, we gave consideration to the alternatives of: (1) constructing the proposed interceptor along the route of the existing interceptor and; (2) constructing a relief interceptor, as required, in a new location along with rehabilitating the existing conduit. Each of these alternatives involves difficult construction in extremely congested areas and great inconvenience to the public. It is also necessary that the existing interceptor continue in service during construction.

The first alternative is not recommended because of the extreme difficulty of constructing the proposed interceptor within streets containing great concentrations of existing utilities, subject to heavy traffic and providing little or no space for another large conduit. The second alternative is not recommended for the above reasons and also because the relief interceptor, which could be located in the proposed route, would require a capacity only slightly less than that which is proposed and would therefore be nearly as expensive to construct as the proposed interceptor. The total cost of this second alternative, including the cost of the rehabilitated existing interceptor, would therefore be considerably more than that of the recommended route and sizes.

Within the Downtown-Waterfront project area, an alternative location of the proposed interceptor in Relocated Atlantic Avenue between Commercial Street and High Street was studied. However, detailed study in conjunction with the BRA consultants indicated that current building programs make the recommended route more desirable.

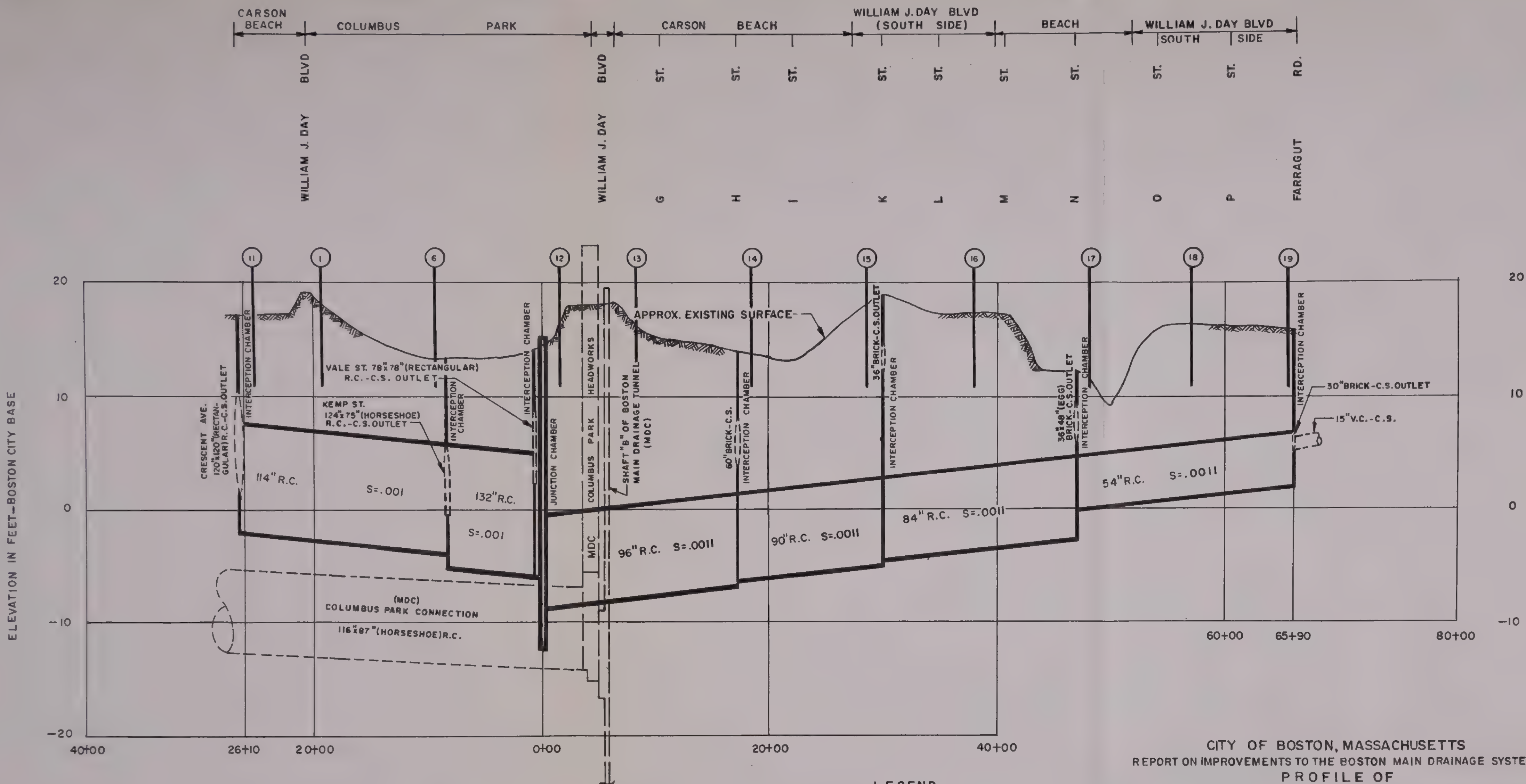
As a result of these considerations, we recommend the route shown on Fig. D, appended to this volume and described above.

Except as otherwise noted, it is expected that open cut construction, with the interceptor supported on piles, will represent adequate construction procedure along the proposed route.

Proposed South Boston Pollution Control Conduit

The proposed South Boston Pollution Control Conduit will be located generally in the beach area along Old Harbor, including Carson Beach. The conduit will be built from a proposed junction chamber at Columbus Park to Outlet No. 93 at Farragut Road on the east and from the proposed junction chamber at Columbus Park to Outlet No. 99, known as the Crescent Avenue outlet, on the south. A plan of this proposed conduit is shown in red on Fig. D, and a profile is shown on Fig. 29. Each existing combined sewer outlet will be intercepted by means of proposed interception chambers, which will have no outlets to Old Harbor except as otherwise described, in such a manner that all tributary flows for a 15 year frequency design storm will be carried by the proposed conduit. Flows in excess of design capacity will overflow to Old Harbor through Outlet Nos. 94, 97 and 99.

At the Farragut Road interception chamber, the East Branch of the proposed South Boston Pollution Control Conduit will be a 54-in pipe which will be constructed parallel to William J. Day Boulevard, on the south side, between existing yacht club buildings and the road to a point between O Street and N Street, at which point the conduit will turn toward the beach and pass parallel and immediately seaward of the existing sea wall and become an 84-in pipe at the proposed interception chamber on the N Street outlet (Outlet No. 94). At this interception chamber a sluice gate will be provided such that flows in excess of conduit capacity will pass into Old Harbor and tide water will not enter the system. The sluice gate may be operated locally and/or by remote control from the proposed Carson Beach Pumping Station. The conduit will pass beneath the sea wall at the foot of M Street and pass between the facilities of the L Street Beach bath house and William J. Day Boulavard and intercept the existing K Street outlet (Outlet No. 95) where it will become a 90-in pipe. Immediately downstream from this point the conduit will once again enter the beach area parallel to the sea wall and intercept the existing combined sewer at the foot of H Street (Outlet No. 96). At H Street, the conduit will become a 96-in pipe and then continue along the beach to a point approximately 200 ft southeast of the existing Columbus Park



LEGEND

C.S. COMBINED SEWER
— — — EXISTING WORKS
⑯ CDM BORING NUMBER

Notes:
1. For Boring Locations See Plan Fig. D
2. For Boring Logs See Appendix G.

CITY OF BOSTON, MASSACHUSETTS
REPORT ON IMPROVEMENTS TO THE BOSTON MAIN DRAINAGE SYSTEM
PROFILE OF
PROPOSED SOUTH BOSTON POLLUTION CONTROL CONDUIT
(INITIAL CONSTRUCTION PROGRAM)
Camp, Dresser & McKee
Consulting Engineers
Boston, Mass.

SCALES: AS INDICATED SEPTEMBER, 1967

FIG. 29

Headworks where it will turn and cross beneath William J. Day Boulevard to enter the proposed junction chamber as shown on Fig. 30.

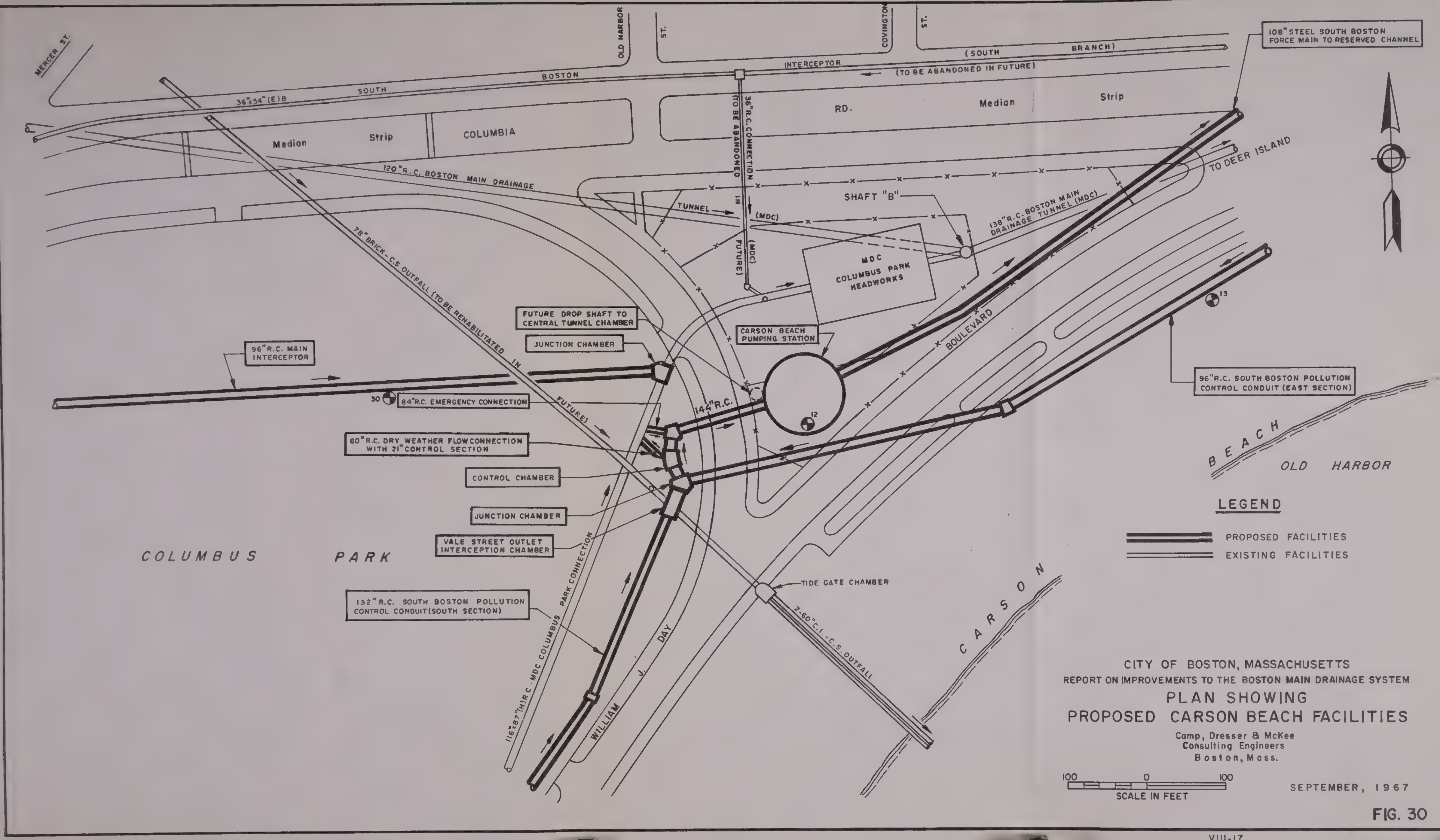
At the Crescent Avenue outlet (Outlet No. 99), the South Branch of the proposed South Boston Pollution Control Conduit will begin at a proposed interception chamber as a 114-in diameter pipe passing to the east of the MDC police station and crossing William J. Day Boulevard as shown on Fig. D. This interception chamber will function as described above for the N Street interception chamber. After crossing the boulevard and entering Columbus Park, the proposed conduit will pass northward parallel to the existing MDC Dolumbus Park Connection to intercept the Kemp Street outlet (Outlet No. 98) at which point it will become a 132-in diameter pipe. The 132-in diameter conduit will intercept the existing Vale Street outlet (Outlet No. 97) immediately upstream of the proposed junction chamber as shown on Fig. 30. The interception chamber on the Vale Street outlet will function as described above for the N Street interception chamber.

The East Branch of the conduit will carry peak dry weather flows estimated for the year 2020 as well as storm flow from a 15 year frequency design storm. The South Branch of the proposed South Boston Pollution Control Conduit will receive only excess dry weather flows reaching the tributary outlets from the existing South Boston Interceptor (Main Stem) and 15 year frequency storm flow. Flows in excess of this will cause surcharging conditions in the proposed conduit resulting in overflows of mixed sewage and storm water to Old Harbor through three existing outlets as described above. The existing South Boston Interceptor (South Branch) and the existing 36-in MDC connection to the South Boston Interceptor may be abandoned upon completion of the proposed South Boston Pollution Control Conduit and the proposed Carson Beach facilities described hereinafter. It is anticipated that construction of the proposed conduit will be performed by the open cut method.

The total estimated area tributary to the South Boston Pollution Control Conduit is about 680 acres. The estimated construction cost of the proposed conduit (and Carson Beach facilities described below) including an allowance for engineering and contingencies is 6,690,000 dollars.

Proposed Carson Beach Facilities

A plan showing the proposed Carson Beach facilities is shown on Fig. 30. The 96-in diameter pipe at the downstream end of the eastern portion of the South Boston Pollution Control Conduit and the 132-in diameter pipe at the downstream end of the southern portion of the conduit enter the proposed junction chamber adjacent to the Vale Street outlet interception chamber. Flows discharge from this proposed junction chamber to the proposed control chamber where flows approximately equal to the total estimated peak dry weather flows will be diverted to the existing MDC Columbus Park Connection Conduit. This proposed dry weather flow connection will be constructed with a short 21-in diameter control section laid on sufficient slope to act as a gravity sewer during peak dry weather flow conditions and provide orifice control during storm conditions, and a 60-in diameter pipe connecting the 21-in section to the existing


MERCER ST.
OLD HARBOR
ST.
COVINGTON
ST.
108" STEEL SOUTH BOSTON FORCE MAIN TO RESERVED CHANNEL
(SOUTH BRANCH)
INTERCEPTOR
(TO BE ABANDONED IN FUTURE)
BOSTON
SOUTH
36"x54" (E)B
Median
Strip
COLUMBIA
RD.
Median
Strip
36" R.C. CONNECTION (TO BE ABANDONED IN FUTURE) (MDC)
120" R.C. BOSTON MAIN DRAINAGE
TUNNEL
(MDC)
SHAFT "B"
TO DEER ISLAND
138" R.C. BOSTON MAIN DRAINAGE TUNNEL (MDC)
MDC COLUMBUS PARK HEADWORKS
78" BRICK-C.S OUTFALL (TO BE REHABILITATED IN FUTURE)
FUTURE DROP SHAFT TO CENTRAL TUNNEL CHAMBER
CARSON BEACH PUMPING STATION
JUNCTION CHAMBER
96" R.C. MAIN INTERCEPTOR
30
84" R.C. EMERGENCY CONNECTION
144" R.C.
12
13
BOULEVARD
96" R.C. SOUTH BOSTON POLLUTION CONTROL CONDUIT (EAST SECTION)
60" R.C. DRY WEATHER FLOW CONNECTION WITH 21" CONTROL SECTION
CONTROL CHAMBER
JUNCTION CHAMBER
VALE STREET OUTLET INTERCEPTION CHAMBER
BEACH
OLD HARBOR
COLUMBUS PARK
TIDE GATE CHAMBER
132" R.C. SOUTH BOSTON POLLUTION CONTROL CONDUIT (SOUTH SECTION)
116"x87" (H) R.C. MDC COLUMBUS PARK CONNECTION
WILLIAM J. DAY
2-60" C.I.-C.S. OUTFALL
CARSON
LEGEND
PROPOSED FACILITIES
EXISTING FACILITIES
100
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SCALE IN FEET

CITY OF BOSTON, MASSACHUSETTS
REPORT ON IMPROVEMENTS TO THE BOSTON MAIN DRAINAGE SYSTEM
PLAN SHOWING
PROPOSED CARSON BEACH FACILITIES
Camp, Dresser & McKee
Consulting Engineers
Boston, Mass.

SEPTEMBER, 1967

FIG. 30

MDC conduit. Excess storm flows will overflow a weir set at a right angle to the direction of flow and enter a 144-in diameter pipe conduit to the proposed Carson Beach Pumping Station described below. An additional connection will be provided from this 144-in diameter conduit to the existings MDC Columbus Park Connection to permit the diversion by means of a sluice gate of all dry weather flows from the existing connection in the event of a shut-down of the existing MDC Columbus Park Headworks for emergency or maintenance reasons. This proposed connection will be an 84-in diameter pipe laid on sufficient slope to provide for the estimated capacity of the existing conduits reaching the headworks. Immediately before entering the proposed Carson Beach Pumping Station, the proposed 144-in pipe will be provided with a blanked-off connection which will permit future diversion of all flows to a proposed drop shaft to be constructed in conjunction with the proposed Deep Tunnel Plan. Estimated costs are included in the cost of the proposed South Boston Pollution Control conduit described above.

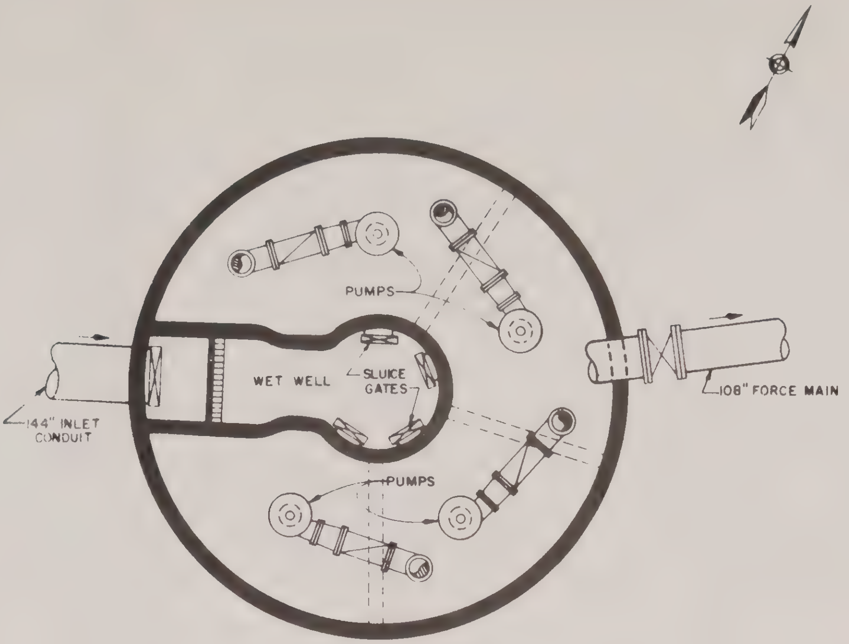
Proposed Carson Beach Pumping Station

We have made preliminary designs for a proposed pumping station which will pump all flows up to the maximum (800 cfs) which may be expected to reach the proposed South Boston Pollution Control Conduit during a 15 year frequency design storm with the existing system of sewerage and drainage. It is considered that significant increases in the capacity of the tributary sewer systems are not likely to be made prior to the construction of the proposed Deep Tunnel Plan.

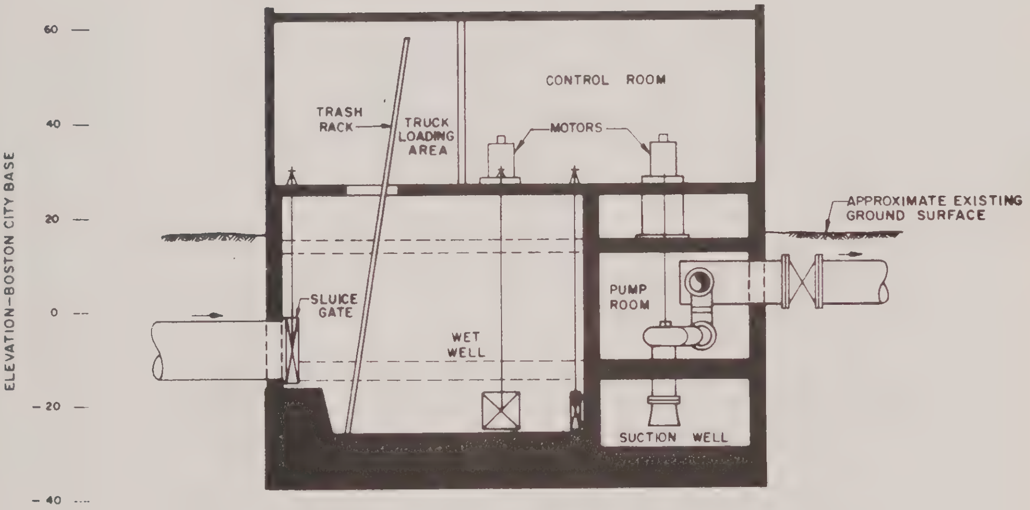
The proposed Carson Beach Pumping Station will receive untreated flows of mixed sewage and storm water as described above and will have provision for screening and hypochlorination facilities. Consideration may be given in the future to a provision for diverting dry weather flows to this pumping station from the existing MDC System between the Columbus Park Headworks and Shaft "B" of the Boston Main Drainage Tunnel in order to take advantage of the screening and grit removal facilities.

A plan and section of the proposed Carson Beach Pumping Station are shown on Fig. 31. The station substructure will be reinforced concrete, approximately 100 ft in diameter and about 62 ft in depth, and the superstructure will be masonry with suitable architectural treatment.

The station equipment and superstructure will be designed with the main floor elevation at approximately Elev. 25 (Boston City Base). The invert elevation of the inlet conduit at the station will be approximately Elev. -14.5. Flow will pass through a coarse, mechanically-cleaned trash rack into the wet well. A heavy duty mechanical trash rake mounted on a frame supported above the main floor will clean the rack. The frame will be equipped with a self-contained hopper for discharging the trash directly into a dump truck inside the station superstructure. The truck will enter and leave through one side of the building, and trash will be transported to the existing South Bay Incinerator or elsewhere for disposal. Then the flow will pass through individual motor-operated sluice gates into the suction wells from which the pumps will take suction. A motor-operated cone valve will be installed on the discharge piping from each pump, and a motor-operated gate valve will be installed where the force main leaves the pumping station in order to provide flexibility of pump operation and permit isolation of individual pumping units or



PLAN
AT PUMP ROOM LEVEL



SECTIONAL ELEVATION

CITY OF BOSTON, MASSACHUSETTS
REPORT ON IMPROVEMENTS TO THE BOSTON MAIN DRAINAGE SYSTEM

PROPOSED CARSON BEACH PUMPING STATION

Camp, Dresser & McKee
Consulting Engineers
Boston, Mass.

20 0 20 40
SCALE IN FEET

SEPTEMBER, 1967

FIG. 31

257-8398

the whole station. Flows will then pass through a 108-in diameter force main to the Reserved Channel as discussed below.

Four pumping units will be required to provide a total station capacity of approximately 800 cfs (360,000 gpm) with a total required operating horsepower of about 6,000. All four pumping units will be installed initially to provide the required capacity. It is understood from Boston Edison Company that the required electric power can be delivered from the vicinity of the South Boston generating station at L Street and that the likelihood of a power failure at this location is extremely remote. Even so, should such a failure occur, no damage would result inasmuch as existing overflows would automatically come into operation.

Each of the four pumping units will have a capacity of 90,000 gpm at a total dynamic head of about 56 ft. They will be single-stage mixed-flow type pumps vertically arranged in a dry pit. Each pump will be driven by a 1,500 horsepower 4,000 volt vertical synchronous motor with a maximum speed of 277 RPM. Two of the motors will be provided with magnetic drives to vary the speed of two of the pumps to closely match the incoming rate of flow.

The motors will be mounted on an intermediate floor located above the pumps, and connected to the pumps by vertical shafting. The motor control equipment will be installed on the main floor level. Catwalks will be provided around each motor as required for servicing.

Hypochlorite solution feeders, control equipment and solution storage facilities will be provided. The solution feed rate will be automatically adjusted to the incoming flow in such a manner that sufficient sodium hypochlorite solution to provide a 30 ppm dosage at maximum pumping rate will be injected into the wet well to provide positive kill of bacteria and viruses within the discharge force main. A chlorine residual recorder controller may be provided to assure accurate dosage of sodium hypochlorite solution.

The estimated construction cost of the proposed Carson Beach Pumping Station including an allowance for engineering and contingencies is 5,000,000 dollars.

In addition to providing a facility for pumping mixed sewage and storm water away from Old Harbor, this station may be utilized to pump all dry weather flows reaching the MDC Columbus Park Headworks in the event that maintenance or emergency conditions require the shutdown of the headworks or the Main Drainage Tunnel. Furthermore, the existing Boston Main Interceptor in Mt. Vernon Street below the existing MDC Columbus Park Connection as described above, the Calf Pasture Pumping Station and the Moon Island Detention Facilities may be abandoned when the proposed Carson Beach Pumping Station and South Boston Force Main are constructed. The proposed facilities, therefore, complement the existing MDC system and the proposed Deep Tunnel Plan.

Proposed South Boston Force Main

The proposed Carson Beach Pumping Station will discharge flows of screened and chlorinated mixed sewage and storm water through a 108-in diameter force main to the Reserved Channel, a total distance of approximately 8,600 ft as shown on Fig. D, appended to this volume. Approximately 4,000 ft of conduit at the downstream end will be designed for gravity discharge and vent facilities will be provided at the high point.

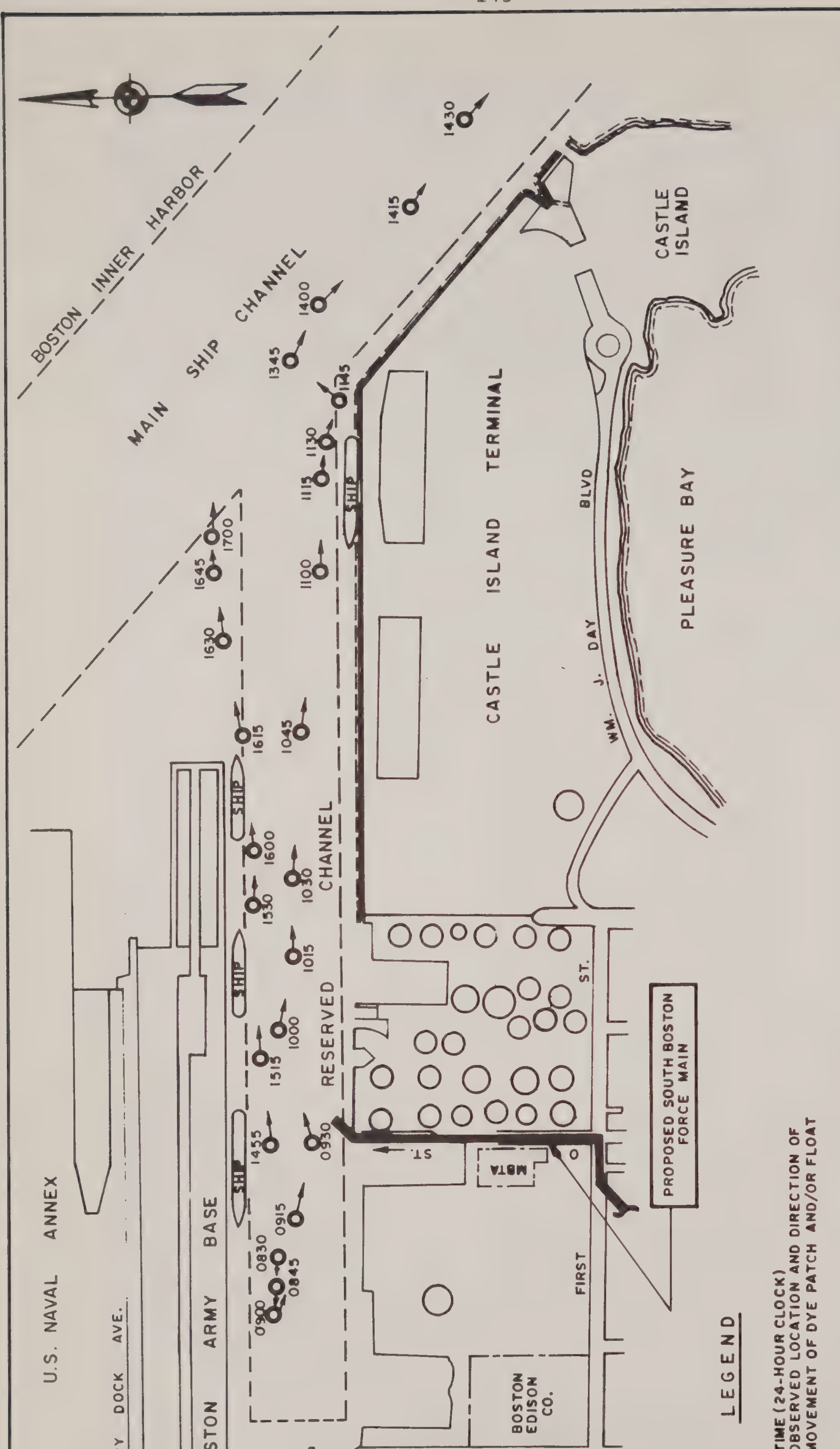
After a thorough investigation of alternative discharge points for the force main, the Reserved Channel is the one most remote from recreational facilities in the area, and its characteristics provide in our opinion, the most feasible and economical outlet.

The proposed force main will leave the pumping station and enter the median strip of Columbia Road near the foot of G Street, then pass eastward along Columbia Road and Marine Road to the intersection of Marine Road and L Street. It will then turn north on L Street and continue across higher ground to East Second Street where it will again turn toward the east and pass along East Second Street crossing diagonally the Christopher J. Lee Playground to East First Street near Acadia Street. The proposed force main will then proceed in East First Street for approximately 200 ft to O Street. At O Street, the proposed force main will turn north and pass between the MBTA power station and the White Fuel Company tank farm, discharging to the Reserved Channel at the pierhead line. This route was chosen to minimize both pumping head and depth of trench requirements as well as to avoid, as much as possible, congested streets. The estimated construction cost of the proposed South Boston Force Main including an allowance for engineering and contingencies is 3,710,000 dollars.

Field investigations were conducted on April 4, 1967 in cooperation with the Massachusetts Department of Public Health for the purpose of determining the length of time required for discharges of screened and chlorinated mixed sewage and storm water from the proposed South Boston Force Main to be carried out of the Reserved Channel by tidal movement. These investigations show that slugs of mixed sewage and storm water from the proposed South Boston Force Main will be carried out of the Reserved Channel within one tide cycle.

On the day of the test, both the fluorescein dye and floats which were used to trace the movement, were carried seaward for at least 8 hours and followed by boat to the tip of Castle Island. The seaward drift began at 9:15 AM, about 2 hours after the predicted high tide, at a point west of O Street extended, and continued until after 5:00 PM (1700 hours), almost 4 hours after the predicted low tide, as shown on Fig. 32. The weather at the time of the test was clear with very little wind after about 10:00 AM. The predicted tide range was about 8 ft which is small for Boston Harbor, and this resulted in relatively little tidal movement in the channel. Thus, conditions for the conduct of this test are considered to have been almost ideal.

As a result of these investigations, we are of the opinion that discharges of mixed sewage and storm water at the foot of O Street will be carried out of the Reserved Channel within 6 to 8 hours after discharge with normal tidal movement.



CITY OF BOSTON, MASSACHUSETTS

REPORT ON IMPROVEMENTS TO THE BOSTON MAIN DRAINAGE SYSTEM

OBSERVATIONS OF TIDAL CURRENTS IN THE RESERVED CHANNEL
SOUTH BOSTON APRIL 4, 1967

Camp, Dresser & McKee
Consulting Engineers
Boston, Mass.

800 0 800
SCALE IN FEET

SEPTEMBER, 1967

FIG. 32

257-8399

Proposed West Side Interceptor

The profile of the proposed West Side Interceptor is shown on Fig. 33.

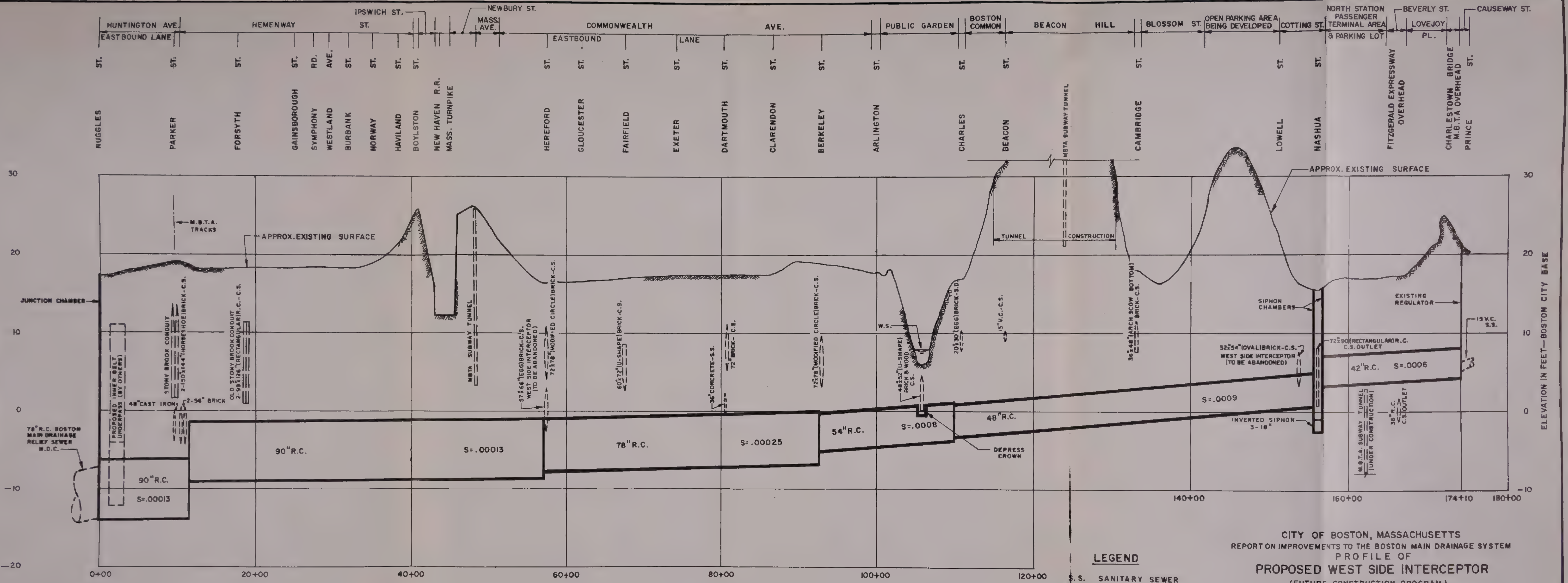
The proposed interceptor will start as a 42-in diameter pipe at its upstream end at an proposed existing regulator which is located at the intersection of Prince and Commercial Streets. It will extend downstream from Commercial Street in open cut across the approach to the Charlestown Bridge and into Lovejoy Place, pass beneath the Fitzgerald Expressway in Beverly Street where it will receive dry weather flow from a proposed rehabilitated regulator, and enter the North Station passenger terminal area and parking lot. As shown on the profile, the 42-in interceptor will pass above the new MBTA subway tunnel which is presently under construction as part of the Haymarket Square-Charlestown extension.

At the east side of Nashua Street, the interceptor will enter an inlet chamber, and as three 18-in diameter inverted siphons, will carry the required design flows beneath an existing outlet conduit in Nashua Street. The interceptor will leave the siphon outlet chamber as a 48-in pipe and pass towards the southwest in Cotting Street, across Lowell Street and into an open area presently being used as a large open parking lot. When this area is developed as part of the planned West End Development, the construction of new buildings should incorporate or otherwise allow for construction of the West Side Interceptor in this area. At Blossom Street the interceptor turns south, passes beneath Cambridge Street and enters Garden Street.

The construction of the interceptor from Prince Street to Garden Street near Phillips Street in Beacon Hill will be in open cut, and piles may be required upstream from Lowell Street. In Garden Street near Phillips Street the interceptor will be a 48-in tunnel for its passage beneath Beacon Hill. The length of the interceptor to be constructed in tunnel is approximately 1,550 feet.

The tunnel section will terminate on the south side of Beacon Street opposite Spruce Street and turn toward the west parallel to Beacon Street, in Boston Common between the street and the Boston Common Underground Garage. The interceptor crosses Charles Street and enters the Public Garden where it will become a 54-in pipe and turn toward the southwest. The interceptor will have a depressed crown where it passes beneath the existing Church Street sewer under the Public Garden pond. Upon leaving the Public Garden the interceptor will cross Arlington Street and enter the eastbound lane of Commonwealth Avenue. At Berkeley Street the interceptor will become a 78-in diameter pipe and will continue at this size to Hereford Street where it will become a 90-in diameter pipe. The interceptor will be constructed in open cut and piles may be required in this area.

The interceptor will turn south in Massachusetts Avenue and extend to Newbury Street, then pass along Newbury Street for approximately 500 ft and turn to the south, crossing beneath the Massachusetts Turnpike and New Haven Railroad tracks to enter Ipswich Street. It will cross beneath Boylston Street and enter Hemenway Street. The



LEGEND

S.S.	SANITARY SEWER
C.S.	COMBINED SEWER
S.D.	STORM DRAIN
— —	EXISTING WORKS

CITY OF BOSTON, MASSACHUSETTS
REPORT ON IMPROVEMENTS TO THE BOSTON MAIN DRAINAGE SYSTEM
PROFILE OF
PROPOSED WEST SIDE INTERCEPTOR
(FUTURE CONSTRUCTION PROGRAM)

Camp, Dresser & McKee
Consulting Engineers
Boston, Mass.

SCALES AS INDICATED SEPTEMBER, 1967

FIG. 33

interceptor will continue in Hemenway Street as a 90-in diameter pipe in open cut, pass beneath the Old Stony Brook Conduit at Forsyth Street, and continue to Huntington Avenue. Here the interceptor will turn to the west and enter the eastbound lane of Huntington Avenue after being lowered several feet at Parker Street to permit it to pass beneath several existing conduits including the Stony Brook Conduit at Parker Street. It then will extend as a 90-in pipe in Huntington Avenue and pass below the depressed roadway section of the proposed Inner Belt before entering the proposed junction chamber at Ruggles Street.

When the planned Inner Belt underpass is constructed, provisions should be made for the interceptor. At Ruggles Street the proposed West Side Interceptor will discharge into the existing 78-in diameter MDC Boston Main Drainage Relief Sewer which carries flows to the Ward Street Headworks.

The location of the proposed West Side Interceptor is completely different from that of the existing interceptor due to the extreme difficulties which would be encountered in attempting to construct a new major sewer in the same streets. The proposed location is the one which appears to offer the least degree of construction difficulty. The design of much of the proposed West Side Interceptor has been checked by computer methods.

In order to carry dry weather flows from areas between the proposed route and the Charles River Basin, it will be necessary to construct local dry weather connections from proposed rehabilitated existing regulator facilities or overflow control chambers to the proposed interceptor. Dry weather flows from the Prudential Center and surrounding areas will enter the proposed interceptor at Fairfield Street and that from the Christian Science Church Center Development and surrounding areas will enter at Hereford Street. The costs for such connections are included in the estimated construction cost of the proposed West Side Interceptor.

The total estimated area tributary to the proposed West Side Interceptor is about 610 acres. The estimated construction cost of the proposed West Side Interceptor including an allowance for engineering and contingencies is 14,500,000 dollars.

Proposed Dorchester Interceptor

The proposed Dorchester Interceptor is shown in plan on Fig. C. The location of the proposed interceptor is shown in the same location as that of the existing interceptor. At such time as a detailed study is made, changes in the location may be indicated. We have made a preliminary design of the proposed interceptor in this location to permit the estimating of construction costs.

The interceptor starts at Granite Avenue in Dorchester Where it will receive flow from the existing MDC Neponset River Valley Sewer, as a 54-in diameter pipe extending cross-country parallel to the New

Haven Railroad Milton Branch to Hallet Street. It runs in Hallet Street and Narraganset Street, and will become a 60-in diameter pipe at Chickatawbut Avenue. It continues generally to the north cross-country to Coffey Street and in McKone Street, cross-country, across Freeport Street, and enters Salina Road and Worrell Street. From Worrell Street it extends cross-country crossing Victory Road where it will receive dry weather flow from a proposed rehabilitated regulator tributary to Outlet No. 103 and become a 66-in diameter pipe. It then passes cross-country to Sturtevant Street. At Christopher Street the interceptor passes beneath the existing Tenean Creek Conduit as a siphon. From Sturtevant Street the interceptor passes generally toward the northeast and beneath the New Have Railroad right-of-way to Ashland and Beach Streets. The proposed 66-in interceptor proceeds in Beach Street to Freeport Street where it turns toward the northwest to Kimball Street, passing beneath the tracks of the MBTA and New Haven Railroad.

At Kimball Street the proposed interceptor will pass beneath two existing outlet conduits and receive dry weather flow from proposed rehabilitated regulators. Mixed sewage and storm water from the two regulators at Kimball Street passes to Outlets No. 100 and 101. At Kimball Street also the proposed interceptor will become a 72-in diameter pipe and continue downstream in Freeport Street to Dorchester Avenue. After turning east from Dorchester Avenue to Hoyt Street the interceptor passes generally northward in Auckland Street where it passes beneath the Freeport Brook Conduit from which it will receive dry weather flows, thence along Belfort Street, Saxton Street, Harltand Street and Sydney Street to Crescent Avenue.

At Crescent Avenue the proposed Dorchester Interceptor will receive dry weather flows from the existing system in Crescent Avenue and turn toward the northeast passing beneath the Southeast Expressway and the MBTA Cambridge-Ashmont rapid transit tracks to Morrisey Boulevard and Mt. Vernon Street. At this point it will enter a proposed junction chamber described in connection with the proposed Mt. Vernon Street sewers.

At its connection with the Mt. Vernon Street sewers, the proposed Dorchester Interceptor will be a 72-in diameter pipe and serve a total estimated tributary area of about 3,030 acres.

The estimated construction cost for the proposed Dorchester Interceptor including an allowance for engineering and contingencies is 13,200,000 dollars.

Proposed South Boston Interceptor - North Branch

The proposed South Boston Interceptor (North Branch replacement) is shown as part of the proposed Future Construction Program shown on Fig. C. The proposed sewer is located in the same position as the existing interceptor, and profiles of the route were drawn as part of our design. More detailed study may indicate that the route should be changed. However, this route provides, in our opinion, a reasonable estimate of the cost of constructing the proposed South Boston Interceptor (North Branch).

As discussed above under the South Boston Pollution Control Conduit recommended in the Initial Construction Program, the South Branch of the South Boston Interceptor is proposed to be abandoned. In addition, a short portion of the North Branch in Dorchester Avenue between Old Colony Avenue and Damrell Street is also proposed for abandonment in conjunction with the Initial Construction Program.

The proposed construction of a replacement for the North Branch of the South Boston Interceptor is described below. At its upper end at L Street it is located in East First Street near the Boston Edison Company power station, where it receives dry weather flows from an existing connection. Downstream from this connection the proposed North Branch will be a 30-in diameter pipe extending in East First Street to I Street. At I Street the interceptor will receive dry weather flows from a rehabilitated regulator in I Street, and the interceptor will become a 42-in diameter pipe continuing westward in East First Street to H Street where it turns south for one block before returning to its westward course. It then continues in East Second Street crossing Dorchester Street. At F Street it will receive dry weather flows from rehabilitated regulators and become a 54-in diameter pipe. It continues in West First Street to C Street where a proposed control structure is proposed to divert combined flows presently tributary to the interceptor. At this point the interceptor will become a 60-in diameter pipe and continue on to B Street where another proposed control structure will be required for the same reason as that at C Street.

Downstream from B Street the proposed interceptor will be a 60-in diameter pipe and pass cross-country beneath the New Haven Railroad Midland Division and Gillette Park to A Street where it will receive dry weather flows from a proposed rehabilitated regulator. Also at A street the interceptor will pass as a siphon beneath an existing combined sewer. Downstream from A Street the North Branch of the South Boston Interceptor continues westward across the property of the Gillette Safety Razor Company to Dorchester Avenue where it will receive dry weather flows from a proposed rehabilitated regulator and enter Foundry Street. At Foundry Street it will turn toward the south, continuing in Foundry Street as a 60-in diameter pipe. At West Fourth Street the interceptor will receive dry weather flow from a proposed rehabilitated regulator, pass on toward the south through New Haven Railroad property and then turn in toward Dorchester Avenue at West Sixth Street. The proposed 60-in diameter interceptor will turn to Dorchester Avenue extending in a southerly direction for short distance to an inverted siphon required to carry flows beneath the tracks of the New Haven Railroad Midland Division. Downstream from the siphon the interceptor will be a 60-in diameter pipe and enter a proposed junction chamber on the proposed Main Interceptor to be constructed as part of the Initial Construction Program.

The total estimated area tributary to the North Branch of the South Boston Interceptor as described above is about 1,000 acres. The estimated construction cost of the proposed North Branch of the South Boston Interceptor including an allowance for engineering and contingencies is 4,000,000 dollars.

South of the proposed junction chamber in Dorchester Avenue at Old Colony Avenue as described above, the existing North Branch Interceptor may be abandoned downstream to D Street. Downstream from D Street the existing North Branch will have adequate capacity to carry all flows tributary to it after the connection at Dorchester Avenue and Old Colony Avenue is effected as described above. We have not proposed a replacement conduit for this section or for the main stem of the South Boston Interceptor for this reason. The total area tributary to the North Branch-Main Stem section of the South Boston Interceptor below D Street, and tributary to the proposed Mt. Vernon Street sewer at Columbia Road is about 205 acres.

Proposed Dorchester Brook Relief Sewer and Conduit System

The proposed Dorchester Brook relief sewers and conduit of the Dorchester Brook sewer system will supplement the capacities of the existing sewers and the upstream portion of the Dorchester Brook Conduit. The existing system consists of the East and West Branch Sewers, the main stem of the Dorchester Brook Sewer from Norfolk Avenue to Massachusetts Avenue and the Dorchester Brook Conduit to the Roxbury Canal Conduit. The capacities of the sewers and conduit of the existing system receiving both dry weather flows and mixed sewage and storm water are adequate only for dry weather flows and are inadequate for the estimated rate of runoff from the 15-year frequency storm rainfall from the total area of about 840 acres tributary at Southampton Street.

Proposed relief sewers and conduits will be constructed generally along the routes of the existing sewers south of Massachusetts Avenue and parallel to the existing conduit from Massachusetts Avenue to the location of a proposed drop shaft at Southampton Street to a tunnel of the proposed Deep Tunnel Plan from Ward Street to Columbus Park.

The estimated total cost of the Dorchester Brook Relief Sewer and Conduit system including an allowance for engineering and contingencies is 10,500,000 dollars.

Proposed East Branch Relief Sewer

The proposed East Branch Relief Sewer will have a total length of about 5,570 ft and capacity at its connection to the proposed junction chamber near Norfolk Avenue of about 200 mgd. The sizes of the pipes in various reaches will be approximately as follows:

Location	Size (in)
Columbia Road to Quincy Street	42
Quincy Street to opposite Cedar Street	84
Opposite Cedar Street to opposite Oleander Street	48
Opposite Oleander Street to Elder Street	42
Elder Street to north of East Cottage Street	48
North of East Cottage Street to proposed junction chamber north of Norfolk Avenue east of New Haven Railroad	118 x 106 horseshoe-shaped section

Proposed West Branch Relief Sewer

The proposed West Branch Relief Sewer will have a total length of about 7,040 ft and a capacity at the proposed junction chamber north of Norfolk Avenue of about 210 mgd. The sizes of the pipe in various reaches will be approximately as follows:

Location	Size (in)
Near Interval Street to Quincy Street	60
Quincy Street to Dewey Street	84
Dewey Street to north of Brookford Street	2-84
North of Brookford Street to Gayland Street (on steep slope)	48
Gayland Street to north of West Cottage Street	66
North of West Cottage Street to Dudley Street	84
Dudley Street to north of Clifton Street	60
North of Clifton Street to proposed junction chamber north of Norfolk Avenue east of New Haven Railroad	84

Proposed Main Stem Relief Sewer and Conduit

The proposed main stem relief sewer and conduit for the Dorchester Brook Sewer System will have a total length of about 3,250 ft and a capacity at the downstream end near Southampton Street of about 770 mgd. The relief sewer will extend approximately parallel to the existing sewer from Norfolk Avenue to Massachusetts and the relief conduit will extend northerly from Massachusetts Avenue approximately parallel to the existing Dorchester Brook Conduit to the proposed drop shaft to the Deep Tunnel Plan System The sizes of the various reaches will be approximately as follows:

Location	Size (in)
Proposed junction chamber near Norfolk Avenue to Massachusetts Avenue	168 x 128 rectangular section
Massachusetts Avenue to proposed drop shaft near Southampton Street	2-198 x 128 rectangular section

At the downstream end of the relief conduit at the proposed shaft north of Southampton Street a control chamber will be provided to conduct mixed sewage and storm water to the head of the drop shaft and to permit dry weather flows to continue northerly in the existing Dorchester Brook

Conduit to the upper end of the proposed Dorchester Brook Dry Weather Flow connection described hereinbefore. Before the section of the existing Dorchester Brook Conduit from Southampton Street to the proposed dry weather flow connection is relieved by the upstream construction described above and is no longer surcharged by tide water, consideration should be given to the possibility that this existing section may be subject to flotation since water pressure inside and outside the conduit may no longer be equalized at all times.

Proposed Stony Brook Interceptor

The proposed Stony Brook Interceptor is shown in plan on Fig. C It will replace the existing Stony Brook Interceptor but will not be located on the same route for its entire length, and flow will be carried in the opposite direction between Kendall Street and Cunard Street. The proposed interceptor will have sufficient capacity to carry the peak rates of dry weather flow from the area which will remain tributary when proposed changes have been made in the sewerage system serving the Stony Brook Valley.

The southern portion of the proposed interceptor will start upstream in Hampshire Street at Linden Park Street where it will receive dry weather flows from proposed rehabilitated regulators serving the local area. Flows now tributary to the existing Stony Brook Interceptor from the West Roxbury Low Level and Stony Brook Valley Sewers will be diverted into the existing Stony Brook conduits as discussed hereinafter.

The interceptor will extend in Hampshire Street to Ruggles Street as a 15-in diameter pipe. At Ruggles Street it will receive dry weather flows from sewers in Ruggles and Cabot Streets and increase in size to a 36-in diameter pipe. The proposed 36-in interceptor will extend in Cabot Street northeasterly from Ruggles and Hampshire Streets to Cunard Street provided the siphon is not constructed. The siphon may be constructed in this area since the sewer route will be crossed from northwest to southeast by the planned Inner Belt highway (Route I-695) at the east side of the interchange with the planned Southwest Expressway (Route I-95). A two-barrel inverted siphon is reported to be planned for the Stony Brook Interceptor crossing in Cabot Street below the depressed highway between the present locations of Weston Street and near Cunard Street. In our estimates we have considered that this siphon will be constructed as part of the highway work.

The interceptor will turn to the north in Cunard Street and continue from Cabot Street across Tremont Street to join the existing MDC Boston Main Drainage Relief Sewer in Columbus Avenue as a 36-in diameter pipe.

The northern portion of the proposed Stony Brook Interceptor will begin near Kendall Street where it will receive dry weather flows from a local sewer and extend in Tremont Street in a southwesterly direction as a 12-in diameter pipe. At Davenport Street the proposed interceptor will become an 18-in diameter pipe and continue in Cabot Street at that size to its junction with the southern portion as the interceptor at Cunard Street as described below.

Short lengths of local sewers will be required to provide for collection of sewage from local areas when the existing interceptor has been abandoned.

The estimated area tributary to the proposed interceptor is about 560 acres, including the Maywoods Brook subdistrict. Dry weather flow from upstream areas now served by the Stony Brook Interceptor are proposed to be discharged to the MDC system through a proposed dry weather connection from the existing Stony Brook Conduit at Ruggles Street. This improvement will be brought about by the proposed change in the intended function of the existing Stony Brook Conduit from storm drain to combined sewer as discussed hereinafter. The portion of the West Roxbury Low Level Sewer downstream of Rossmore Road which now connects to the interceptor at Elmwood Street, and the Stony Brook Valley Sewer may be abandoned.

The existing Stony Brook Interceptor and the connection to the existing Main Interceptor at Camden Street may be abandoned.

The estimated construction cost of the proposed Stony Brook Interceptor including an allowance for engineering and contingencies is 1,200,000 dollars. This cost includes the cost of abandoning the existing interceptor and constructing the proposed dry weather connection at Parker Street but not for diverting all dry weather flows upstream from Linden Park Street to the Stony Brook conduits, the cost for which is included in the estimated cost for the proposed West Roxbury Low Level Relief Sewer. Flows of mixed sewage and storm water in excess of the capacity of the proposed interceptor will be discharged from proposed rehabilitated regulators to the overflow conduits connected to the Old Stony Brook Conduit as described hereinafter.

Proposed West Roxbury Low Level Relief Sewer

The existing West Roxbury Low Level Sewer is discussed herein as two sections located with respect to Rossmore Road, north of Forest Hills. Rossmore Road is essentially the northerly limit of the area of about 450 acres now served on the separate system by this sewer. A relief sewer is proposed for the section of sewer upstream from Rossmore Road and abandonment for the section downstream to carry dry weather flows in excess of the capacity of existing sewer.

It is proposed to connect the upstream section of the existing conduit directly to the existing Stony Brook Conduit at Rossmore Road and Meehan Street. Upstream of Rossmore Road the capacity of the sewer will be supplemented for part of its length by the proposed West Roxbury Low Level Relief Sewer extending parallel to it north from Washington Street at Franklin Place to the proposed connection at Rossmore Road.

The proposed West Roxbury Low Level Relief Sewer and the existing Low Level Sewer together will serve an estimated area of about 410 acres upstream of Rossmore Road. The relief sewer from near Franklin Place to Morton Street will be an 18-in diameter pipe and from near Morton Street to Rossmore Road will be a 24-in diameter pipe. The construction of the proposed relief sewer will be affected by the construction of the planned Southwest Expressway. The route of the relief sewer will be approximately parallel to the existing sewer but must be located to suit the planned expressway construction.

It is proposed to abandon the existing West Roxbury Low Level Sewer downstream from Rossmore Road. The Stony Brook Conduit will carry all dry weather flows from the West Roxbury Low Level Sewer and mixed sewage and storm water from tributary areas in Stony Brook Valley north of Rossmore Road to the location of the proposed dry weather connection to the existing MDC Boston Main Drainage Relief Sewer at Parker and Ruggles Streets, as described hereinbefore. The sewage from small areas now served by the West Roxbury Low Level Sewer north of Rossmore Road will then be diverted by connections to the Stony Brook Conduit. Some sections of the sewer north of Rossmore Road proposed for future abandonment may be rebuilt for current use as part of the planned expressway construction.

The cost of the proposed West Roxbury Low Level Relief Sewer including the principal connection at Rossmore Road, connections from sewers serving small areas north of Rossmore Road to the Stony Brook Conduit and abandonment of the existing sewer north of Rossmore Road, is estimated to be 1,050,000 dollars including an allowance for engineering and contingencies.

Proposed Stony Brook Storm Water Diversion System

The proposed Stony Brook Storm Water Diversion System will divert all storm water and other surface runoff from the portion of the Stony Brook Valley drainage area south of Rossmore Road-McBride Street to the Neponset River. Flow would be diverted at this point from the existing Stony Brook Conduit which now discharges to the Back Bay Fens and the Charles River Basin as described in Chapter III.

The proposed system of diversion conduits and connections is shown on Fig. C appended to this volume. It includes the proposed Stony Brook Storm Water Diversion Conduit, Canterbury Brook Storm Water Diversion Conduit, Upper Stony Brook Storm Water Conduit, Goldsmith Brook Storm Water Diversion Conduit and Kelly Field Storm Water Diversion Conduit which are described hereinafter.

The purpose of the proposed diversion system is to make sufficient capacity available in the existing Stony Brook Conduit north of Rossmore Road for flows of mixed sewage and storm water resulting from a 15 year design storm from the portion of the area tributary north of Rossmore Road. All dry weather flows which now are carried by the West Roxbury Low Level Sewer and Stony Brook Valley Sewer, will be diverted into the existing Stony Brook Conduit. The existing West Roxbury Low Level Sewer north of Rossmore Road and the existing Stony Brook Valley Sewer will be abandoned as discussed hereinafter. Thus the portion of the existing Stony Brook Conduit north of Rossmore Road will function as a combined sewer. Although it presently functions as a combined sewer, it has inadequate capacity for 15 year storm flows. This portion of the conduit north of Rossmore Road will have sufficient capacity if storm water flows from the upper Stony Brook Valley area are diverted as proposed.

To carry storm water flow to the proposed Stony Brook Storm Water Diversion Conduit, the capacity of existing major storm water drains must be supplemented by the other proposed conduits and connections listed above. To prevent mixed sewage and storm water from reaching the proposed storm water diversion system a short length of sanitary sewer must be constructed in Corinth Street as required and the connection from the existing sanitary sewer to an adjacent storm drain discontinued.

The proposed Stony Brook Storm Water Diversion System will, as discussed above, reduce the volume and rate of runoff reaching the Charles River Basin. In our opinion, the proposed system offers two major advantages; (1) reducing the rate of discharge to the basin during critical storm periods thereby reducing the likelihood of flooding and (2) eliminating the discharge of mixed sewage and storm water to the basin.

An alternative system has been considered which would divert storm water runoff from areas upstream from Rossmore Road to the Charles River Basin through a new conduit and utilize the existing Stony Brook Conduit as proposed above. This alternative system is not recommended because its construction cost would be much greater than the proposed system. It would require open cut construction of a very large shallow conduit through densely populated areas. Furthermore, only slight augmentation of low flow in the Charles River Basin, which might be obtained by this alternative system, would be realized.

The estimated total construction cost of the proposed Stony Brook Storm Water Diversion System including an allowance for engineering and contingencies is 67,000,000 dollars.

Proposed Stony Brook Storm Water Diversion Conduit. The principal diversion conduit is the proposed Stony Brook Storm Water Diversion Conduit which will carry storm water by gravity from the vicinity of Rossmore Road and Meehan Street to tide water in the Neponset River estuary. Consideration should be given to constructing a storm water diversion connection at Meehan Street from the existing storm drain in Williams Street east of the Stony Brook Conduit. The proposed Stony Brook Storm Water Diversion Conduit will extend about 1,200 ft generally southeasterly in Rossmore Road from its intersection with Meehan Street to Forest Hills Street in open cut, as a rectangular conduit equivalent in capacity to a 20 ft diameter circular section. From Forest Hills Street it will pass southeasterly as a 20 ft diameter tunnel for about 4,500 ft to a proposed junction chamber north of the American Legion Highway east of Morton Street. At this point the conduit will be joined by the proposed Canterbury Brook Storm Water Diversion Conduit and continue southeasterly as a 21-1/2 ft x 20 ft rectangular section, to a drop shaft chamber near Harvard Street, where a connection will be made from the existing upper Canterbury Brook storm drain in Hansborough Street. From the chamber the conduit will extend southeasterly as twin 20 ft diameter tunnels or equivalent section about 9,900 ft to an outlet headwall at the Neponset River tidal estuary southeast of Pierce Square at Dorchester Lower Mills. The outlet will be downstream of the MBTA bridge and about 0.2 mi. downstream of the Chocolate Mill dam.

The proposed Stony Brook Storm Water Diversion Conduit will serve a total area of about 6,500 acres in the southern or upland portion of the Stony Brook Valley, exclusive of the small area which will be served by the Kelly Field Storm Water Diversion Conduit.

Proposed Canterbury Brook Storm Water Diversion Conduit. The proposed Canterbury Brook Storm Water Diversion Conduit will divert flow which now reaches the existing Stony Brook Conduit upstream from the present Canterbury Brook junction, near Brook Street, and flow from the portion of the open channel of Canterbury Brook southwest of Harvard Street to the proposed Stony Brook Storm Water Diversion Conduit. The proposed Canterbury Brook conduit will be about 17 ft in diameter or have a section of equivalent hydraulic capacity and be constructed in tunnel or open cut for approximately 4,700 ft of its length, generally parallel to the existing brook channel from the junction chamber at the existing Stony Brook Conduit about 900 ft northeast of Mt. Hope Street to about 1,400 ft northeast of Walk Hill Street. It will continue north of the American Legion Highway to the proposed junction chamber at the Stony Brook Storm Water Diversion Conduit.

The proposed drop shaft connection from the existing upper Canterbury Brook storm drain described hereinbefore will divert all storm flows from upstream areas of the Canterbury Brook drainage area directly into the proposed Stony Brook Storm Water Conduit. Such a diversion will reduce the required capacity of the existing Canterbury Brook open channel downstream of the proposed Canterbury Brook Storm Water Diversion Tunnel.

From about 800 ft northeast of Walk Hill Street the Canterbury Brook Storm Water Diversion Conduit will be parallel to the proposed Talbot Avenue High Level Relief Sewer discussed hereinafter. To avoid possible conflict in selection of locations for the proposed conduit and the relief sewer, the design of these works will require close coordination.

At times of high rates of storm water runoff, the direction of flow in the portion of the existing Stony Brook Conduit from its junction with Roslindale Brook at Brookway Terrace southeast to the junction with Canterbury Brook will be reversed by the low hydraulic gradient made available at the point of diversion to the proposed Canterbury Brook Storm Water Diversion Conduit, and at such times storm water from Roslindale Brook will discharge to the proposed conduit. This will reduce the capacity required in the existing Stony Brook Conduit north of the existing Roslindale Brook connection to Rossmore Road and will eliminate the need for a relief conduit for this portion of the Stony Brook Conduit.

Proposed Upper Stony Brook Storm Water Conduit. The capacity of the upper reaches of the existing Stony Brook Conduit from the present upper end of the brook enclosure at Bald Knob Road near Gordon Avenue to its junction with Canterbury Brook about 900 ft northeast of Mt. Hope Street is inadequate for the design rates of storm water runoff from the tributary area as discussed in Chapter III. The proposed Upper Stony Brook Storm Water Conduit will be constructed to provide sufficient capacity to reduce local flooding and to conduct storm water to the point of diversion to the proposed Canterbury Brook Storm Water Diversion Conduit. Portions of the existing Stony Brook Conduit in this area may require rehabilitation and be utilized in the future. The route of the proposed conduit will be generally parallel and adjacent to the existing conduit.

The existing Stony Brook Conduit extends generally northeasterly from the open channel at Bald Knob Road as a 72-in diameter reinforced concrete pipe in Gordon Avenue, in easement, Beaver and Austin Streets, and in easement to the west side of the tracks of the Providence Division of the New Haven Railroad, and thence continues northerly as a 72-in pipe along the west side of the tracks to Grew Avenue near Mansur Street. It passes easterly beneath the tracks and in easement as an 84-in diameter pipe to the east of Navarre Street, northeasterly in easement to Columbia Street, and in easement north of Chase Street to north of Jalleison Street, thence continues as a 144-in x 120-in rectangular reinforced concrete conduit in easement southwest of Cummins Highway to the intersection with the American

Legion Highway and in easement northwest of the American Legion Highway to near Mt. Hope Street, thence as a 180-in x 156-in rectangular reinforced concrete culvert to the junction with the existing Canterbury Brook drain.

The proposed conduit for the relief and replacement of the upper reaches of the Stony Brook Conduit will consist of three sections, (1) a relief conduit roughly parallel to the existing conduit from an entrance at the open channel at Bald Knob Road to the west side of the planned Southwest Expressway right-of-way, (2) a replacement conduit northerly along the west side of the planned expressway from about 700 ft south of West Street to near Mansur Street and easterly beneath the expressway to Hyde Park Avenue and (3) a relief conduit from Hyde Park Avenue roughly parallel to the existing Stony Brook Conduit to the proposed point of diversion to the proposed Canterbury Brook Storm Water Diversion Conduit. Sizes of the proposed conduit sections are based on the use of circular pipes flowing full at approximately the same invert slopes as those of the existing conduits upstream of Willow Avenue, and of rectangular sections with about 12-in of freeboard for the conduit north of Willow Avenue.

From the upper end to near Beaver Street the proposed relief conduit section will be a 66-in diameter pipe, and from Beaver Street to the planned Southwest Expressway it will be a 72-in diameter pipe.

The proposed replacement conduit section along the west side of the planned express-way will be a 96-in diameter pipe to Morton Street and will continue to Willow Avenue as a 144-in diameter pipe or equivalent section. Provision must be made for a replacement storm drain of adequate capacity to replace an existing 30-in diameter storm drain in Willow Avenue which will be crossed by the expressway. It will continue to near Mansur Street as a 156-in x 144-in rectangular shaped conduit and extend to Hyde Park Avenue, crossing beneath the expressway as a 180-in x 156-in rectangular shaped conduit or equivalent section.

The location of the proposed conduit section from about 700 ft south of West Street to near Mansur Street may be changed by the design of the proposed South-west Expressway. It is planned by the highway consultants that the existing 72-in pipe in that reach be replaced by a pipe in a location suitable to the highway construction. We estimate that the existing conduit in this reach provides less than half of the estimated storm flow capacity required. Relief of the 72-in pipe is therefore not recommended and replacement in this reach by a new conduit with capacity for the full estimated flow rate is proposed.

The proposed relief conduit from Hyde Park Avenue to Jallieson Street will be a 180-in x 156-in rectangular shaped conduit or equivalent section, continue as a 168-in x 156-in rectangular shaped conduit to near Mt. Hope Street and extend to the proposed diversion chamber at Canterbury Brook as a 144-in x 156-in rectangular shaped conduit or equivalent section.

The reach of proposed conduit from Cummins Highway northeast to the proposed diversion chamber will extend parallel to the proposed Talbot Avenue High Level Relief Sewer which is described hereinafter. Design and construction of the proposed conduit and sewer must be coordinated to obtain the most favorable location for each.

The total length of the proposed Upper Stony Brook Storm Water Conduit will be about 12,700 ft.

Proposed Goldsmith Brook Storm Water Diversion Conduit. The proposed Goldsmith Brook Storm Water Diversion Conduit will receive storm flows from the open channel of Goldsmith Brook and from the existing 54-in storm drain from the north at the upstream end in the Arnold Arboretum west of St. Joseph Street. The proposed conduit will divert storm water flows from the areas of about 440 acres now served by separate sewers west of the Arborway directly to the Stony Brook Conduit upstream of the Rossmore Road diversion. The proposed diversion conduit will reduce flows in the existing conduit now carrying the Goldsmith Brook flow such that its capacity will then be adequate to carry mixed sewage and storm water from the area served by tributary combined sewers. The existing connection from Goldsmith Brook and the upstream storm drain to the 54-in conduit downstream of the point of diversion may be abandoned and sealed.

The proposed Goldsmith Brook Storm Water Diversion Conduit will extend from a proposed diversion chamber in the Arnold Arboretum generally easterly in St. Joseph Street, Woodman Street, and Jamaica Street to South Street as a 96-in diameter pipe and continue in Boynton Street to Call Street as a 84-in diameter pipe. It will pass beneath the planned Southwest Expressway (the present Providence Division tracks of the New Haven Railroad) as a 96-in diameter pipe and extend in Burnett Street and Brookley Road to a proposed junction chamber on the existing Stony Brook Conduit near Stoneley Road east of Washington Street. The total length of the proposed diversion conduit will be about 3,800 feet.

Proposed Kelly Field Storm Water Diversion Conduit. The proposed Kelly Field Storm Water Diversion Conduit will conduct the flow from an area of about 200 acres from the southern portion of the Stony Brook Reservation and adjacent land southerly to the Mill Pond reach of Mother Brook. We have made an economic comparison which indicates that the construction cost for works to divert the flow from this area directly to Mother Brook and thence to the Neponset River will be less than to provide larger conduits than now exist or are proposed to convey the flow northerly across Smith's Pond Playground, through several proposed conduits of the Stony Brook Storm Water Diversion System to the Neponset River tidal estuary.

The proposed Kelly Field Storm Water Conduit will be a 60-in diameter pipe extending for about 1,700 ft. From the point of diversion at Stony Brook near the north corner of Factory Hill Playground the conduit will extend southerly parallel to Turtle Pond Parkway and across Kelly Field and River Street to the outlet at the Mill Pond northeast of the Neponset Valley Parkway crossing.

Miscellaneous Proposed Improvements to Stony Brook System

Abandonment of Stony Brook Valley Sewer. It is proposed to abandon the existing Stony Brook Valley Sewer northerly of McBride Street except as described below. Existing connections from the combined sewers tributary to the Stony Brook Valley Sewer will be rehabilitated or reconstructed as necessary and connected directly to the existing Stony Brook Conduit. Dry weather flow will be discharged from the conduit through the proposed Ruggles Street Dry Weather Flow Connection to the existing MDC Boston Main Drainage Relief Sewer, and the excess mixed sewage and storm water will be discharged to the Back Bay Fens or through the westerly Foul Flow Channel to the Charles River Basin. After the proposed Deep Tunnel Plan is constructed, such flows will be discharged at a proposed drop shaft at Parker Street.

The sewer serves an area of about 1,460 acres sewered on the combined system located in Jamaica Plain and Roxbury. Its estimated capacity is generally adequate for the estimated rates of dry weather flow but grossly inadequate for estimated flows of mixed sewage and storm water from the presently connected tributary area. Flows of mixed sewage and storm water are now discharged from the Stony Brook Valley Sewer through a number of connections to the Stony Brook Conduit. The sewer is considered to serve little useful purpose and abandonment is therefore recommended.

The reach of the existing Stony Brook Valley Sewer from McBride Street at Call Street northerly in Call Street to Green Street should be retained, if in adequate structural condition, as an outlet for the Goldsmith Brook combined sewer in McBride Street. If that reach is determined to be not structurally sound, a connection may be constructed from Call Street across the right-of-way of the proposed Southwest Expressway and in McBride Street and Rossmore Road to the existing Stony Brook Conduit in Meehan Street.

The Stony Brook Valley Sewer now discharges to the Boston Main Drainage System through the Stony Brook Interceptor as discussed hereinbefore. We have included in our estimates the cost of abandoning the Stony Brook Valley Sewer from Green Street northerly to the existing connection to the Stony Brook Interceptor.

The cost of the proposed abandonment and necessary connections is estimated to be about 300,000 dollars, including an allowance for engineering and contingencies.

The Stony Brook Valley Sewer will be affected for most of its length by the planned construction of the Southwest Expressway. Sections of this sewer proposed for future abandonment may be rebuilt for current use as part of the expressway project.

Stony Brook Conduit North of Rossmore Road. The section of the existing Stony Brook Conduit north of Rossmore Road to Boston Gate House No. 1 at the Back Bay Fens may require rehabilitation for continued future use. The reach between Rossmore Road and Parker Street at Ruggles Street is proposed for use as a combined sewer to carry dry weather flows from the existing West Roxbury Low Level Sewer and proposed relief sewer south of Rossmore Road in addition to all dry weather flows and mixed sewage and storm water flows from the tributary area north of Rossmore Road. The existing West Roxbury Low Level Sewer south of Rossmore Road and the entire Stony Brook Valley Sewer will be abandoned when appropriate connections have been completed as discussed hereinbefore.

At Ruggles Street a proposed dry weather flow connection will connect from the Stony Brook Conduit to the existing MDC Boston Main Drainage

Relief Sewer. This connection will include control facilities such that peak dry weather flows may be discharged to the MDC facilities, and excess flows of sewage and storm water will continue to pass through downstream reaches of the Stony Brook Conduit (Commissioners Channel) to Boston Gate House No. 1 for discharge either to the Fens or through the 144-in by 144-in Foul Flow Channel to the Charles River Basin.

When the proposed Deep Tunnel Plan is constructed, a drop shaft will be included to divert mixed sewage and storm water flows from the Stony Brook Conduit (Commissioners Channels) to the deep tunnel near Parker Street and Annunciation Road. Thereafter the Commissioners Channels and westerly Foul Flow Channel from Annunciation Road to the Charles River Basin may be abandoned.

Forsyth Street Outlet Conduit. The Old Stony Brook Conduit (not to be confused with the Stony Brook Conduit and Commissioners Channels) now carries in a northerly direction flows of mixed sewage and storm water from the combined sewers tributary to the existing Stony Brook Interceptor and from combined sewers at Hampshire and Whittier Streets, Tremont Street, Ruggles Street and Huntington Avenue. This conduit is inadequate in capacity, and because of its age a replacement conduit called the Forsyth Street Outlet Conduit is proposed.

When the proposed Deep Tunnel Plan is constructed, it is recommended that the proposed outlet conduit be constructed to carry mixed sewage and storm water in excess of the available capacity of the proposed West Side Interceptor at Huntington Avenue and Forsyth Street southerly in Forsyth Street and Whittier Street to a proposed drop shaft to the proposed deep tunnels. The drop shaft will be located in the vicinity of Whittier Street and Tremont Street.

Possibly one or both of the conduit barrels of the Old Stony Brook Conduit in Forsyth Street and Whittier Street may be suitable for rehabilitation as the outlet conduit. Portions of the Old Stony Brook Conduit to be replaced by construction of the planned Southwest Expressway -Inner Belt Highway interchange may be utilized as part of the proposed outlet conduit. A portion of the existing Old Stony Brook Conduit north of Huntington Avenue to Boston Gate House No. 2 and the Foul Flow Conduit to the MDC Fens Gate House at the Charles River Basin may be either abandoned or retained as an outlet conduit for storms of intensity greater than the design storm.

Proposed East Boston Low Level Sewer

The proposed East Boston Low Level Sewer will replace the lower reaches of the existing East Boston Low Level Sewer which is inadequate to serve portions of the Orient Heights section of East Boston. The proposed sewer will receive mixed sewage and storm water from the 62-acre area which is recommended to remain sewered by the combined-sewer method, downstream of the Moore Street outlet (Outlet No. 3). Existing outlets would remain in service until the proposed Deep Tunnel Plan is constructed.

The proposed East Boston Low Level Sewer will replace the existing East Boston Low Level Sewer from Saratoga Street at Boardman Street to the connection to the existing MDC East Boston Branch Sewer near the Addison Street Pumping Station following generally the alignment of the existing sewer. The proposed sewer will be a 66-in diameter pipe from Boardman Street for about 1,400 ft to opposite Trident Street where the sewer from Moore Street joins, and continue as an 84-in diameter pipe for about 2,900 ft to a proposed control chamber upstream of the connection to the MDC sewer. The proposed control chamber will replace the existing regulator structure. The route of the conduit is in generally unimproved marshland bordered by an oil tank farm. The existing sewer may be abandoned in conjunction with the proposed construction.

The proposed conduit will have capacity for storm water runoff from the tributary area served by combined sewers plus an allowance for peak dry weather flow from the area upstream served by separate sanitary sewers and storm drains. The dry weather flow from the areas served by the sewer will be discharged as at present to the MDC system near the Chelsea River.

The existing East Boston Low Level Sewer has insufficient capacity to carry estimated flows of mixed sewerage and storm water. We recommend the construction of a replacement sewer rather than a relief sewer for two reasons:

1. When the proposed Deep Tunnel Plan is constructed, only one conduit of sufficient capacity will be required to carry mixed sewage and storm water.

2. A relief sewer, if it were constructed, would have to be approximately the same size as the proposed replacement sewer inasmuch as the existing sewer has sufficient capacity only for estimated dry weather flows, and the existing sewer may be abandoned.

The estimated construction cost of the total length of about 4,300 ft of the proposed sewer and the control chamber including an allowance for engineering and contingencies is 2,000,000 dollars.

Proposed Talbot Avenue High Level Relief Sewer

The proposed Talbot Avenue High Level Relief Sewer will supplement the dry weather flow capacity of the lower reaches of the existing Talbot Avenue High Level Sewer from Lyford Street to the connection to the MDC South Metropolitan High Level Sewer. These reaches do not have capacity adequate for estimated future dry weather flows, but are considered to be adequate at the present time. The proposed relief sewer will be located in a position different from the existing sewer for part of its length as described below.

The proposed relief sewer will connect to the existing sewer at Lyford Street and Callender Street and extend southerly in Lyford Street as a 42-in diameter pipe and continue in Woodrow Avenue to Irma Street, north to Balsam Street, and west in Balsam Street and Johnston Road to Harvard Street at Morton Street. It will continue as a 42-in diameter pipe in easement in the grounds of the Boston State Hospital to American Legion Highway and pass along the highway becoming parallel to the existing sewer to Walk Hill Street. From there the relief sewer will extend as a 48-in diameter pipe southwesterly parallel to the existing sewer on the north side of the highway to join the MDC sewer at Cummins Highway.

The proposed relief sewer from about 800 ft northeast of Walk Hill Street near the American Legion Highway to about 900 ft northeast of Mt. Hope Street will be located in the vicinity of the proposed Canterbury Brook Storm Water Diversion Conduit as described hereinbefore. From about 1,000 ft northeast of Mt. Hope Street near the American Legion Highway to the South Metropolitan High Level Sewer at Cummins Highway, it will extend parallel to the proposed Upper Stony Brook Storm Water Conduit. The locations for the relief sewer and the proposed conduits will require close coordination during final design.

The existing sewer served a separated area of about 1,300 acres in the Dorchester district of the city. The total length of the proposed relief sewer is about 11,500 ft. The estimated construction cost including an allowance for engineering and contingencies is 1,950,000 dollars.

Proposed Improvements to Outlets and Appurtenant Facilities

The improvement of outlets and appurtenant facilities which are necessary for successful operation of the interceptors and conduits proposed in the Initial and Future Construction Programs, includes the cleaning of regulator sumps, tide gate chambers and dry weather flow connecting pipes, and the repair, adjustment and replacement of tide gates. Some typical improvements are shown on Fig. 34. Some outlets are to be abandoned and permanently sealed, and the construction of one complete tide gate chamber is recommended. After the proposed Deep Tunnel Plan is constructed, all existing outlets and appurtenant facilities may be abandoned.

For those tide gate installations at which gates are missing or damaged beyond repair, new metal or wooden gates and frames are recommended where required. Proposed gates are of the same size or larger than those to be replaced. Reduction in size is not recommended because of possibility of causing flood damage by restricted passageways. For replacement of gates originally installed in series, however, only one of the two gate openings need be provided with a gate closure. This should be installed at the more accessible location, which is generally at the downstream opening. It is our opinion that the additional advantages to be gained by installing gates in series is insignificant inasmuch as clogging tends to be progressive,and such installation is therefore not recommended.

The several types of outlets and their appurtenant facilities which are presently provided in the existing Boston sewerage systems are described in Chapter III. A detailed description and the estimated capacity of each outlet are included in Table 1 of Appendix D. Outlets comprise all components for the diversion, transmission and discharge of mixed sewage and storm water from combined sewers to the receiving bodies of water. Proper operation will require a continuing preventive maintenance program.

Proposed improvements to existing combined sewer outlets and appurtenant facilities are required to help alleviate the intolerable conditions presently found in the vicinity of most of them until the proposed Deep Tunnel Plan is constructed. These improvements will, in addition, tend to reduce the degree of surcharging in existing sewers now affected by tide water and reduce the amount of sewage discharged to the harbor and surrounding waters through the outlets. Until dry weather interceptors and overflow conduits are constructed as proposed herein for the Initial

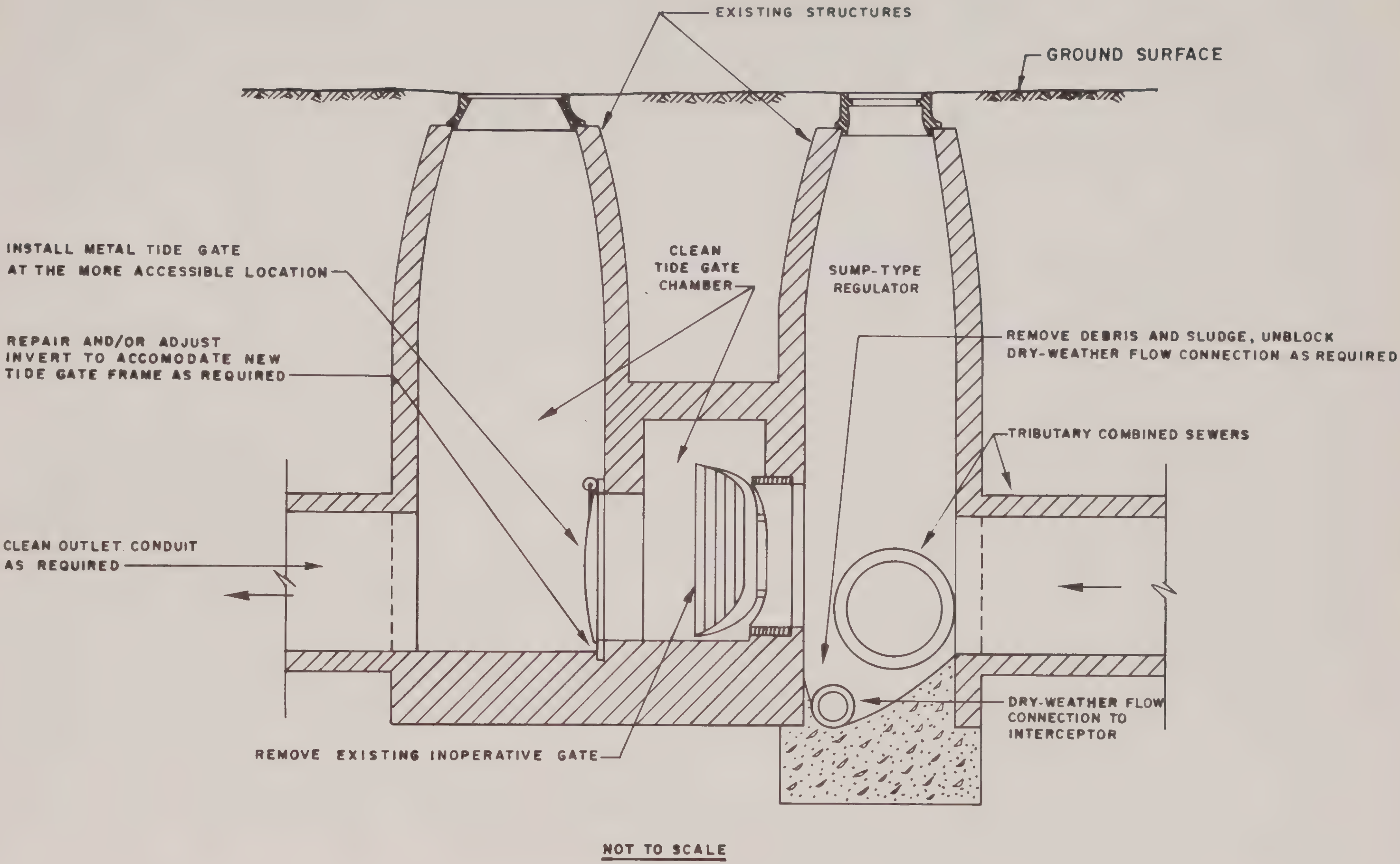

EXISTING STRUCTURES
GROUND SURFACE
INSTALL METAL TIDE GATE AT THE MORE ACCESSIBLE LOCATION
CLEAN TIDE GATE CHAMBER
SUMP-TYPE REGULATOR
REMOVE DEBRIS AND SLUDGE, UNBLOCK DRY-WEATHER FLOW CONNECTION AS REQUIRED
REPAIR AND/OR ADJUST INVERT TO ACCOMODATE NEW TIDE GATE FRAME AS REQUIRED
TRIBUTARY COMBINED SEWERS
CLEAN OUTLET CONDUIT AS REQUIRED
DRY-WEATHER FLOW CONNECTION TO INTERCEPTOR
REMOVE EXISTING INOPERATIVE GATE
NOT TO SCALE

FIG. 34 TYPICAL IMPROVEMENTS TO COMBINED SEWER OUTLETS

and Future Construction Programs, frequent sewage overflows will continue to occur even during dry weather at most of these outlets because of the inadequate capacities of the existing interceptors.

By reducing the height and duration of surcharges, greater accessibility to the interceptors and regulators for inspection and maintenance will be provided than now exists. The proposed improvements will result in reduction in the amounts of sludge and debris deposited by the elimination of periods, of low velocities at times of flow reversal or blockage, during inflows of tide waters. In addition, tide water will no longer directly enter the Union Park Street Pumping Station, the Calf Pasture Pumping Station or MDC connections.

The estimated cost of the proposed improvements to outlets and appurtenant facilities in both the Initial and Future Construction Programs, including an allowance for engineering and contingencies is $400,000. This estimated cost does not include the cost of rehabilitating the Union Park Street Pumping Station or the cleaning of outlet conduits.

Benefits of Proposed Improvements

The benefits which will accrue to Boston and its citizens from construction of the improvements to the Boston Sewerage System proposed under the Initial and Future Construction Programs, are listed below.

1. Tide water will no longer enter the system thus reducing the quantities of flow to be carried, pumped and disposed of.

2. Interceptors with adequate capacities together with properly functioning overflow control chambers and tide gates will prevent dry weather flows of sewage from overflowing to the harbor including the Charles River Basin.

3. Excessive quantities of storm and tide water will no longer enter the interceptors causing surcharged conditions.

4. The proposed South Boston Pollution Control Conduit will prevent the discharge of mixed sewage and storm water to Old Harbor.

5. Pollution of Boston Harbor, Charles River Basin, and Neponset River will be reduced.

6. Maintenance of the proposed facilities will be much easier to accomplish than at present, resulting in better operation.

7. All improvements can be fully utilized when the proposed Deep Tunnel Plan is constructed.

8. Abandonment and elimination of existing aged conduits will reduce the hazards of collapse and risk of injury to persons and property.

IX CONSTRUCTION PROGRAMS AND FINANCING

General

All proposed construction of sewers and conduits, except for that which is considered as part of the proposed Deep Tunnel Plan, is fully described in Chapter VIII. The proposed Deep Tunnel Plan is described in Chapter VII and in more detail in Appendix F.

The recommended Initial and Future Construction Programs are each shown in plan on Fig. C appended to this volume. The recommended Initial Construction Program is shown in red, the recommended Future Construction Program in green and the proposed Deep Tunnel Plan in blue. The Initial Construction Program is shown in greater detail in red on Fig. D appended to this volume and is recommended for construction as soon as financing permits.

The Future Construction Program is recommended for construction after the completion of the Initial Program. The various items of work included in this program should be constructed as soon thereafter as possible with priorities depending upon the most immediate needs and availability of financing at that time. A tentative order of construction priority is shown in Table 23.

Items included in each of the recommended construction programs, together with estimated construction costs, are described hereinafter.

The proposed Deep Tunnel Plan should be implemented at the earliest possible date to obtain maximum benefit from all other improvements proposed herein.

Estimated Costs of Construction

Basis of Estimates

All construction cost estimates for the recommended Initial and Future Construction Programs are based on contractors' bid prices for similar work in the Boston and New York City areas. The estimates for proposed sewers are based on the use of vitrified clay pipe with watertight joints up to 15-in. in diameter and precast reinforced concrete pipe with watertight joints for sewers above 15-in. in diameter. For large conduits, estimates are based on the use of monolithic cast-in-place reinforced concrete sections of appropriate shape to suit conditions.

The cost estimates include an allowance for sheeting where required for depth or where unfavorable soil and water conditions are likely to prevail or where required for the protection of existing structures or utilities. Piles and concrete cradles are included where required to adequately support sewers and conduits.

Allowances for rock excavation and difficult construction have been based on observations and borings. The boring logs are shown in Appendix G of Vol. 2. The cost of handling water in trenches has been included for sewers and conduits located where wet conditions are expected to prevail. Where existing pavement must be removed and replaced, the estimates include the cost based on a width of pavement 3 ft wider than the expected top width of the trench. The cost estimates include the cost of manholes and are based on standard 4 ft or 5 ft diameter brick or concrete manholes with brick inverts and cast-iron frames and covers for sewers less than 36-in. in diameter. For larger sewers and conduits estimates include costs for cast-in-place reinforced concrete manholes and junction chambers.

The estimates include jacking where required to permit instruction without interrupting rail or highway traffic. In addition, the estimates include cost for tunnelling where required beneath Beacon Hill. Allowances for traffic control in busy city streets are included.

Items included in estimates for proposed pumping stations are covered in detail in descriptions of the stations. In general, however, the estimates are based on brick and steel superstructures and reinforced concrete substructures and include costs for pumping units, drive units, power supply facilities, control equipment, trash racks and chlorination facilities.

Estimated costs for the proposed Deep Tunnel Plan are based on unit prices furnished by large contractors with tunnelling experience and by manufacturers of tunnelling equipment. Items included in these estimates are described in Chapter VII and Appendix F.

The cost estimates in the report include an allowance for engineering (design, services during construction, surveying, and inspection) and contingencies. The cost estimates in this report are based upon the preparation of plans and specifications for competitive bidding.

All construction cost estimates are referred to an Engineering News-Record (ENR) Cost Index of 1100. Construction costs have been increasing at a rate of between 3 and 5 per cent per year. The ENR cost index reflects the trend of construction costs available and has been widely used to update previous cost estimates to current-day figures. If, at some time in the future, up-to-date construction cost estimates are desired, the costs in this report may be multiplied by the ratio of the ENR cost index for Boston at that future time to 1100.

Recommended Initial Construction Program

A summary of the facilities proposed for construction as part of the recommended Initial Construction Program is presented in Table 21 together with estimated construction costs for various portions of the work. Detailed descriptions of each item of work are presented in Chapter VIII. As an integral part of the initial program, we recommend that improvements be made to existing outlets and appurtenant facilities serving existing combined sewer systems, as listed in Table 22.

The estimated total cost of the recommended Initial Construction Program is 37,850,000 dollars. No work in tributary sewer systems is included except as specifically described.

TABLE 21 ESTIMATED COST OF RECOMMENDED INITIAL CONSTRUCTION PROGRAM

Proposed Facilities	Estimated Construction Costs	
Main Interceptor	$ 7,100,000*	
Dorchester Brook Dry Weather Connection	240,000	
Massachusetts Avenue Sewers	750,000	
Mt. Vernon Street Sewers		
Massachusetts Avenue to Columbus Park	2,180,000	
Columbia Point to Columbus Park	700,000	
East Side Interceptor Roxbury Canal Branch (Massachusetts Avenue to Union Park Street)	3,880,000*	
Improvements to Outlets and Appurtenant Facilities	200,000	
		$15,050,000
South Boston Pollution Control Conduit		
East Branch	$ 4,360,000*	
South Branch	2,330,000	
Carson Beach Pumping Station	5,000,000	
South Boston Force Main	3,710,000	
		$15,400,000
East Side Interceptor Atlantic Avenue to Union Park Street		$ 7,400,000
ESTIMATED TOTAL COST		$37,850,000
Eligible for Grants		$22,740,000*

*Facilities that appear eligible at this time for Federal (P.L. 84-660) grants and State (Mass. Clean Waters Act of 1966) grants.

TABLE 22 RECOMMENDED IMPROVEMENTS TO EXISTING COMBINED SEWER OUTLETS - INITIAL CONSTRUCTION PROGRAM

Outlet Number	Location	Recommended Improvements	Estimated Cost of Improvements
60	Commercial Street at Hanover Street	Clean sump and tide gate chamber. Repair one 24-in metal tide gate.	$1,500
61	Commercial Street at Battery Street	Clean sump and tide gate chamber. Adjust one 24-in metal tide gate.	1,000
62	Commercial Street at Clark Street	Clean sump, dry weather connection and tide gate chamber. Install one new 24-in metal tide gate.	2,500
64	Atlantic Avenue at Clinton Street	Clean sump, dry weather connection and tide gate chamber. Adjust two 60-in x 60-in wood tide gates.	1,500
66	Atlantic Avenue at Central Street	Clean sump, dry weather connection and tide gate chamber. Install one 72-in x 72-in wood tide gate. Reconstruct invert for stop-log chamber.	6,500

NOTES

1. The estimated costs for constructing control chambers and dry weather flow connections, where required, to proposed interceptors are included in estimated construction costs for such interceptors.

2. For tidegate chambers which could not be inspected because of surcharged conditions, allowances have been made for installing tide gates.

TABLE 22 RECOMMENDED IMPROVEMENTS TO EXISTING COMBINED SEWER OUTLETS - INITIAL CONSTRUCTION PROGRAM (Continued)

Outlet Number	Location	Recommended Improvements	Estimated Cost of Improvements
67	Atlantic Avenue south of High Street	Clean sump and tide gate chamber. Repair one 24-in metal tide gate.	$1,500
218	Atlantic Avenue at Oliver Street	None	-
68	Congress Street at Gilbert Place	Clean tide gate chamber. Adjust two 36-in metal tide gates.	1,500
69	Summer Street at Dorchester Avenue	Clean two sumps at Atlantic Avenue, dry weather connections and tide gate chamber. Adjust two 60-in wood tide gates.	2,500
70	Atlantic Avenue at Kneeland Street	Clean sump. Adjust two 36-in metal tide gates. Remove planks in tide gate openings.	1,500
72	Albany Street north of Traveler Street	Clean sump and tide gate chambers. Adjust two 60-in x 60-in tide gates.	1,000

TABLE 22 RECOMMENDED IMPROVEMENTS TO EXISTING COMBINED SEWER OUTLETS - INITIAL CONSTRUCTION PROGRAM (continued)

Outlet Number	Location	Recommended Improvements	Estimated Cost of Improvements
73	Dover Street at Harrison Avenue and Albany Street	Clean sump and tide gate chamber. Remove existing tide gates and install one 48-in tide gate. Clean debris from end of 48-in outlet.	$3,500
74*	Union Park Street at Albany Street (High Level)	Clean sump and tide gate chamber. Remove upstream tide gate and install one 84-in x 84-in wood tide gate.	5,000
75*	Union Park Street at Albany Street (Low Level from Pumping Station)	Clean sump and tide gate chamber. Remove existing tide gate and install one 69-in x 54-in wood tide gate.	4,500
76*	East Dedham Street at Albany Street	Clean sump and tide gate chamber. Remove wood tide gate and adjust one 60-in metal tide gate.	1,000
77*	East Concord Street at Albany Street	Clean sump and tide gate chamber. Remove upstream wood tide gate and adjust downstream 81-in x 87-in wood tide gate.	1,000

*For descriptions in Table 1, Appendix D, see Outlet No. 219.

TABLE 22 RECOMMENDED IMPROVEMENTS TO EXISTING COMBINED SEWER OUTLETS - INITIAL CONSTRUCTION PROGRAM
(continued)

Outlet Number	Location	Recommended Improvements	Estimated Cost of Improvements
79 *	Massachusetts Avenue north of Roxbury Canal Conduit.	Clean sump and tide gate chamber. Remove existing tide gate and install one 60-in metal tide gate.	$3,000
80 *	Massachusetts Avenue south of Roxbury Canal Conduit.	Clean sump, dry weather connection and tide gate chamber. Remove existing tide gates and install one 48-in metal tide gate.	2,500
81*	Dorchester Brook Sewer at Massachusetts Avenue	Abandon regulator and dry weather connection. Remove four tide gates.	1,500
82*	Damrell Street and D Street at Dorchester Avenue	Clean two sumps and three tide gate chambers. Remove all four existing tide gates.	1,500
83*	Dorchester Avenue at B Street	Clean sump and two tide gate chambers. Remove existing tide gates and install one 78-in x 92-in wood tide gate at downstream tide gate chamber.	6,000

*For descriptions in Table 1, Appendix D, see Outlet No. 219.

TABLE 22 RECOMMENDED IMPROVEMENTS TO EXISTING COMBINED SEWER OUTLETS - INITIAL CONSTRUCTION PROGRAM (continued)

Outlet Number	Location	Recommended Improvements	Estimated Cost of Improvements
84	Foundry Street at West Fourth Street	Clean sump, dry weather connection and tide gate chamber. Install one 24-in metal tide gate.	$2,000
85	Dorchester Avenue near Foundry Street	Remove two tide gates and install one 60-in metal tide gate.	3,000
86	Mt. Washington Avenue at A Street	Brick up outlet from regulator.	1,000
220	West First Street at D Street, F Street at West First Street, D Street north of Cypher Street	Clean three sumps and four tide gate chambers. Remove four tide gates. Install one 84-in metal tide gate in rehabilitated chamber near outlet.	6,500
90	I Street at East First Street	Clean two regulator chambers, two dry weather connections and tide gate chamber. Remove two tide gates, install one 48-in metal tide gate and install new inverts in regulator chambers.	6,000

TABLE 22 RECOMMENDED IMPROVEMENTS TO EXISTING COMBINED SEWER OUTLETS - INITIAL CONSTRUCTION PROGRAM
(continued)

Outlet Number	Location	Recommended Improvements	Estimated Cost of Improvements
91	Summer Street north of East First Street	Clean sump and two tide gate chambers. Adjust two 24-in and one 30-in tide gates.	$1,000
92	Farragut Road at East First Street	Clean two sumps, two dry weather connections and two tide gate chambers. Adjust one 24-in metal and two 78-in x 72-in wood tide gates.	2,500
93	Farragut Road at East Sixth Street	Clean sump. Remove one 18-in metal tide gate. Brick dry weather connection. Abandon tide gate chamber and outlet.	1,000
94	N Street at Day Boulevard	Clean two sumps and tide gate chamber. Remove two existing tide gates. Brick dry weather connection. Construct control chamber.	2,000
95	K Street at Marine Road	Clean sump. Abandon outlet.	500
96	H Street at Marine Road	Clean tide gate chamber. Remove two existing 60-in tide gates. Brick dry weather connection. Abandon outlet.	1,500

TABLE 22 RECOMMENDED IMPROVEMENTS TO EXISTING COMBINED SEWER OUTLETS - INITIAL CONSTRUCTION PROGRAM (continued)

Outlet Number	Location	Recommended Improvements	Estimated Cost of Improvements
97	Rev. R.A. Burke Street below Marine Road and Day Boulevard (formerly Vale Street)	Clean tide gate chamber. Remove four 48-in wood tide gates and two flushing gates. Brick dry weather connection. Construct control chamber.	$2,000
98	Kemp Street at Henry Sterling Square, Murray Way at Old Colony Way	Clean three sumps and three tide gate chambers. Remove four 54-in x 78-in, two 36-in and two 60-in wood tide gates. Brick dry weather connections to South Boston Interceptor. Abandon outlet and flushing gate chamber.	5,000
99	Crescent Avenue, Carson and Sidney Streets, Morrissey Boulevard and Mt. Vernon Street	None at Carson Street. Clean one regulator chamber, one dry weather connection and two tide gate chambers. Remove two 48-in and four 90-in x 96-in wood tide gates. Construct control chamber.	3,000
100	Southeast Expressway east of Freeport Way at Malibu Beach	None	-

TABLE 22 RECOMMENDED IMPROVEMENTS TO EXISTING
COMBINED SEWER OUTLETS - INITIAL
CONSTRUCTION PROGRAM
(continued)

Outlet Number	Location	Recommended Improvements	Estimated Cost of Improvements
101	Dorchester Avenue near Hancock Street to Freeport Way and Fox Point, Freeport Street at Kimball Street	Clean two sumps, nine tide gate chambers and two dry weather connections. Remove 17 existing tide gates and install two 90-in x 82-in wood tide gates at Fox Point. Block 12-in dry weather connection at Auckland Street north of Hoyt St.	$16,000
103	Park Street near Dorchester Avenue to Sturtevant Street and Victory Road	Clean three sumps, five chambers and two dry weather connections. Remove two tide gates and adjust one 36-in metal tide gate. Construct one tide gate chamber with two 72-in x 84-in wood tide gates north of Victory Road.	75,000
104	Ericson Street at Port Norfolk Street	Clean sump, dry weather connection, and tide gate chamber. Repair one 15-in tide gate.	1,000
106	Neponset Avenue, Craddock Street and Walnut Street to Neponset River	Clean one sump, dry weather connection and two tide gate chambers. Remove two tide gates. Adjust two metal tide gates.	1,500

TABLE 22 RECOMMENDED IMPROVEMENTS TO EXISTING COMBINED SEWER OUTLETS - INITIAL CONSTRUCTION PROGRAM (continued)

Outlet Number	Location	Recommended Improvements	Estimated Cost of Improvements
107	Minot Street at Granite Street to Hallet Street	Clean four chambers and one dry weather connection. Raise weir at Adams Street. Remove two 48-in wood tide gates and install one new 48-in metal tide gate.	$ 3,500
109	Granite Avenue at New Haven Railroad Milton Branch	Clean two chambers and one dry weather connection. Remove one 48-in wood tide gate and adjust one 48-in metal tide gate.	1,500
			$186,000
		Miscellaneous Items	14,000
		TOTAL ESTIMATED COST OF IMPROVEMENTS	$200,000

Facilities recommended for inclusion in the Initial Construction Program have been selected to provide the maximum relief from problems of inadequate hydraulic capacity of aged existing sewers and conduits. Construction of the proposed South Boston Water Pollution Control Conduit, Carson Beach Pumping Station and South Boston Force Main will not only permit the abandonment of the existing South Boston Interceptor (South Branch) but will result in the elimination of pollution of Carson Beach and other beaches facing Old Harbor due to the discharge of raw sewage and mixed sewage and storm water. The proposed improvements to 42 outlets and appurtenant facilities such as regulators, tide gates and connections will, with proper maintenance, prevent the entrance of tide water into tributary portions of the sewerage system and subsequent discharge of mixed sewage and tide water to nearby bodies of water. Such improvements will enable the proposed interceptors to function properly.

All facilities included in the initial program will be located within the Boston Main Drainage District, and all dry weather flows from the proposed facilities will discharge to the existing MDC Columbus Park Headworks for subsequent disposal. All flows of mixed sewage and storm water in excess of the capacities of proposed facilities will discharge to the waters of Boston Harbor until such time as the proposed Deep Tunnel Plan is constructed and placed into operation.

Recommended Future Construction Program

A summary of the facilities proposed for construction as part of the recommended Future Construction Program is presented in Table 23 together with estimated construction costs for various portions of the work.

The estimated total cost of the recommended Future Construction Program is 118,900,000 dollars. No work in tributary sewer systems is included except as specifically described.

All facilities recommended for inclusion in the future program are considered to be less urgently required at this time than those recommended for the Initial Construction Program. However, the estimated hydraulic capacities of existing sewers and conduits which are proposed for relief, replacement or abandonment are either inadequate for design flows of sewage or for mixed sewage and storm water.

The observed conditions and capacities of all existing combined sewer outlets are listed in Table 1, Appendix D of Vol. 2. Improvements are proposed under the future program for all outlets and appurtenant facilities not included in the initial program, unless prior the scheduling of construction of the proposed Deep Tunnel Plan calls for abandonment of the outlets. The work involves a total of 49 outlets with a total estimated cost of 200,000 dollars. All other facilities proposed for construction under the future program will serve most effectively in conjunction with the proposed Deep Tunnel Plan.

TABLE 23 ESTIMATED COST OF RECOMMENDED FUTURE CONSTRUCTION PROGRAM

	Proposed Facilities	Estimated Construction Costs
1.	Improvements to Outlets and Appurtenant Facilities	$ 200,000
2.	East Side Interceptor Hanover Street to Relocated Atlantic Avenue	1,700,000
3.	Canal Street Sewer	1,300,000
4.	West Side Interceptor	14,500,000
5.	Dorchester Interceptor	13,200,000
6.	Stony Brook Interceptor	1,200,000
7.	West Roxbury Low Level Relief Sewer	1,050,000
8.	Stony Brook Storm Water Diversion System	67,000,000
9.	Abandonment of Stony Brook Valley Sewer	300,000
10.	South Boston Interceptor - North Branch	4,000,000
111.	Dorchester Brook Relief Sewer and Conduit System	10,500,000
12.	East Boston Low Level Sewer	2,000,000
13.	Talbot Avenue High Level Relief Sewer	1,950,000
	ESTIMATED TOTAL COST	$118,900,000

NOTE: Proposed facilities are listed in a tentative order of construction priority.

Maintenance and Operation of Recommended Facilities

Satisfactory operation of the facilities recommended for construction in the Initial and Future Construction Programs depends upon an effective cleaning and maintenance program. Expenditures of large sums of money required for the construction programs warrant annual expenditures for maintenance and operation sufficient to assure that investments for construction are protected and provide maximum effectiveness of pollution abatement facilities on a continuing basis.

Existing facilities are in many cases, very difficult to maintain and operate properly due to their complexity, age and current condition as previously noted. Records from other cities indicate that more maintenance time and money are spent on older sewers than newer sewers. It therefore, in our opinion, behooves the city to simplify and modernize its sewerage and drainage systems as discussed hereinbefore.

It is essential that adequate appropriations, sufficient trained personnel, modern equipment and a system-wide preventive maintenance program be provided not only for recommended facilities but for those now existing.

We estimate that the average annual cost of operation and maintenance of the facilities in the recommended Initial Construction Program will be approximately 550,000 dollars including costs for labor, electric power, sodium hypochlorite solution and maintenance and repair. We estimate that the average annual cost of operation and maintenance of the facilities in the recommended Future Construction Program will be about 300,000 dollars. These costs do not include costs for maintenance and operation of existing facilities which are to remain in service.

Federal Financial Assistance

Communities which need to construct, improve or extend their water systems, sewer systems and sewage treatment works may be able to obtain financial help from the Federal government. Such assistance to Boston may be provided by Federal agencies as discussed below.

Department of the Interior

Under the Federal Water Pollution Control Act (Public Law 84-660 as amended), effective as of July 1, 1967, the dollar limitation on grants for sewage treatment works, interceptors, outfalls, pumping stations and their appurtenances for a single project or a joint project is completely eliminated. In all cases, the amount authorized for the Federal grant for either a single or a joint project is at least 30 per cent of the total cost of such facilities. If a State agrees to match 30 per cent of the total cost the Federal grant is increased to 40 per cent. (Massachusetts has enacted legislation providing for State financial assistance to supplement Federal construction grants as discussed hereinafter). Furthermore, if a State agrees to pay not less than 25 per cent of the total cost, the Federal grant will be increased to a maximum of 50 per cent, if enforceable water quality standards (classification) have been established for the waters into which the project discharges. (Massachusetts has adopted such standards and they have been approved by the Federal Water Pollution Control Administration). An additional 10 per cent of any Federal grant may be awarded for any project that is part of a metropolitan areawide plan.

Department of Housing and Urban Development

One of the many extensive purposes of the Housing and Urban Development Act of 1965 (Public Law 89-117) is to encourage cities to construct adequate basic water and sewage works in order to promote their efficient and orderly growth. It provides grants to local public bodies and agencies to finance specific projects for water works and for basic sewer facilities other than sewage treatment plants and interceptors for which grants are available under the Federal Water Pollution Control Act. No grant will be made for a sewer facility until treatment works have been provided. The amount of any grant will not exceed 50 per cent of the construction cost of a basic water or sewer facility, but under certain special conditions enumerated in the Act, the amount may be increased for a basic public sewer facility to not more than 90 per cent. No grant for either water or sewer facilities will be made unless the Secretary determines that the project is necessary for the improvement of health and living standards of the people in the community and meets the criteria established by the Department for an area-wide water or sewer facilities system as part of the comprehensively planned development of the area. Grants are made under this program to finance both preliminary and final project planning.

Although portions of the Initial Construction Program may be eligible under this act, applications for funds far exceed the funds appropriated.

Department of Commerce

The Public Works and Economic Development Act of 1965 (Public Law 89-136), replaces and fuses the now expired Area Redevelopment Act of 1961 (ARA) and the Public Works Acceleration Act of 1962 (APW). The stated purpose of this legislation is to help areas and regions of substantial and persistent unemployment and underemployment to take effective steps in financing their public works and economic development. Its main emphasis is on economic development. Grants are authorized for public works construction and rehabilitation to States or political subdivisions representing any "redevelopment area" or part thereof. (A "redevelopment area" is one where there has been substantial and persistent unemployment for an extended period of time). To be eligible the project must directly or indirectly (1) improve opportunities for establishment or expansion or industrial plants or facilities, (2) assist in creation of long-term employment opportunities, and (3) benefit the long-term unemployed and members of low-income families.

The project must also fulfill a pressing need of the area and must be in an area which has an approved overall economic development program (OEDP). An overall program for the economic development of the area must be submitted to and approved by the Secretary, together with a finding by the State, or any agency, instrumentality or political subdivision that the project is consistent with such program.

No grant will be made under this Act for sewer or other waste disposal facility unless adequate treatment is provided prior to the discharge of any waste into a public waterway.

Supplementary grants are authorized in order that full advantages may be made of Federal grant-in-aid programs by State and other entities within redevelopment areas which, because of their economic situation, cannot furnish the required matching share. The amount of any direct grant will not exceed 50 per cent of the project cost. The amount of any supplementary grant will be such that the non-Federal share of the aggregate project cost shall not be less than 20 per cent.

Boston is not eligible at this time under this program.

State Financial Assistance

Recent legislation, popularly termed "The Massachusetts Clean Waters Act of 1966" provides for a comprehensive state water pollution control program. This law established the Division of Water Pollution Control in the Department of Natural Resources, provided for an accelerated water pollution control program by authorizing a 150 million dollar bond issue, provided tax incentive assistance for industries to build and operate waste treatment facilities, and provided for a permanent special legislative commission to oversee the implementation of the law.

The Division of Water Pollution Control is subject to the control of the Massachusetts Water Resources Commission in its administration and enforcement of the State program. The ten-year 150 million dollar bond issue authorized provides State aid to cities, towns and districts to supplement available Federal funds and assist them in the construction of the necessary waste treatment facilities. The total principal amount of bonds that may be issued or sold in any fiscal year beginning July 1, 1966 may not exceed 15 million dollars.

State assistance is provided for surveys, plans and specifications for the construction by the cities and towns of waste treatment facilities, intercepting sewers and pumping stations necessary to abate, control and prevent pollution of the waters of the Commonwealth because of sewage or industrial or other wastes. It is expected that grants of up to 30 per cent of construction costs for eligible projects will be provided.

Financing the Recommended Initial Construction Program

We suggest that the recommended Initial Construction Program be financed by the issuance of 30-year bonds. The bond market at the present time is such that 30-year municipal bonds will probably carry an interest rate of about 4.00 per cent. For this interest rate and term Table 24 shows the expected principal and interest costs for Boston.

We suggest that the recommended Initial Construction Program be paid for in part by Federal and State grants as indicated on Table 24, with the remaining cost to the city to be raised by general taxation. Table 24 indicates a tax rate increase of about $0.99/1000 dollars of valuation for Boston's share of the recommended Initial Construction Program based on a real and personal property valuation of 1,531,000,000 dollars and an announced 1967 tax rate of $117.80/1000 dollars of valuation.

The interest charge shown in Table 24 will decrease with each subsequent year as the principal is reduced. Estimated annual costs for operation and maintenance are now shown in Table 24 inasmuch as they will be offset in part by the elimination of such costs resulting from the recommended abandonment of existing facilities including the Calf Pasture Pumping Station and Moon Island Detention Facilities.

TABLE 24 FINANCING THE RECOMMENDED INITIAL CONSTRUCTION PROGRAM

Total Estimated Construction Cost		$37,850,000
Estimated State Aid (25% of $22,740,000)	$5,680,000	
Estimated Federal Aid (50% of 22,740,000)	11,370,000	
Total State and Federal Aids	$17,050,000	17,050,000
Construction Cost to be Financed Locally		$20,800,000*
Annual Principal Payment for 30 Years		$ 693,000
First Year Interest Payment on Unpaid Balance at 4% per year		832,000
Estimated Total Annual Cost to City		$1,525,000
First Year Increase in Property Tax Rate per $1,000 of Assessed Valuation		$0.99

* At the time of construction, the City should investigate other possible Federal and State aid programs then existing to determine if this local share could be further reduced.

X CONNECTIONS TO THE METROPOLITAN SEWERAGE SYSTEM

General

We have studied all sewer connections from the Boston Sewerage System to the Metropolitan Sewerage System. The existing Metropolitan Sewerage System owned and operated by the MDC is described in Chapter IV. At present, there are 139 public connections and 79 special connections.

Public connections, as the name implies, are connections to the MDC system from common sewers serving the public and are generally located in city streets. Special connections, on the other hand, are private connections from individual houses or other buildings and not from public sewers. The MDC assesses the City for both types of connections.

Public and Special Connections

Public connections in current use, including four recently constructed connections from the Boston Main Drainage System, are listed in Table 25 in Appendix E of Vol. 2 together with size, tributary area and rated capacity of each. Rated capacities have been calculated in the same manner as "initial demand" capacities calculated by the MDC as discussed hereinafter. It should be noted that all connections to the MDC Neponset Valley Sewer easterly from near Monponset Street to Granite Avenue are not assessed separately because flows from these connections enter the Dorchester Interceptor before they reenter the MDC system at Mt. Vernon Street connection (CDM Connection No. 139) for which assessment is made.

The approximate locations of all public connections to the existing MDC sewerage system are shown on Fig. E appended to this volume. We have assigned a CDM connection number to each connection to aid in identification. Corresponding MDC connection numbers and districts in which they are located are as shown in Table 25. We have noted three connections listed by MDC to be bulkheaded and abandoned, one could not be located on city plans, and three unlisted connections were found as discussed hereinafter.

Method of Assessment

Boston, along with the other 40 cities and towns served wholly or in part by the MDC sewerage system, must pay the Commonwealth of Massachusetts annually for debts incurred by the construction of sewerage facilities, in accordance with Section 5, Chapter 92 of the General Laws as amended. The method of assessment is described in Section 5 as follows:

> "The proportion to be paid by each city and town of the total annual amount shall be determined by dividing the aggregate capacity of municipal sewers of each city and town connected to sewers operated by the commission by the total capacity of all municipal sewers connected to district sewers provided, however, that in no case shall the aggregate capacity of any municipal sewer used in the determination of such ratio be

> greater than the prorated capacity of the district sewer at the point of such connection. At every point on the metropolitan sewerage system at which the capacity of the main sewer is less than the aggregate capacity of the sewers converging at that point, the available capacity of the main sewer shall be apportioned among the two or more lines converging at such point in proportion to the capacities of such converging lines."

In November 1966, Boston was assessed about 1,150,000 dollars which represented about 18.14 per cent of the total yearly MDC sewerage system assessment for principal and interest on serial bonds required to finance construction. This assessment did not include charges for the four recently constructed Boston Main Drainage connections because diversion of flows through these connections has not been accomplished by November 1, 1966. When these diversions are made, Boston's share of the total MDC assessment for principal and interest will reportedly increase to about 38 per cent of the total or about 2,410,000 dollars, based on total principal and interest charges of 6,341,267 dollars on MDC bonded indebtedness as of June 30, 1967.

The annual operation and maintenance charges of MDC are assessed or a population basis. (For 1966 Boston was assessed 533,500 dollars). The Initial and Future Construction Programs recommended in this report will have no effect on this assessment.

Capacities of Connections

We have obtained the initial demand-capacity (hydraulic capacity of a connection at a velocity of 2 fps) figures computed by the MDC for each connection in the city. We are in agreement with these figures as shown in Table 25 except for those public connections which we have found from our investigation to be either bulkheaded or abandoned and are therefore not shown in Table 25. We have found East Boston MDC Connection No. 12 to be abandoned. East Boston MDC Connection No. 26 could not be located on Sewer Division plans or in the field but may be a water blow-off connection. Brighton MDC Connection No. 7 is understood to be bulkheaded as shown on city plans. Roxbury MDC Connection No. 1 has been abandoned and replaced by CDM Connection No. 121. CDM Connection No. 14 located in East Boston is shown on city plans but could not be found in the field and is reported to have been abandoned. CDM Connection No. 94 located in Hyde Park is shown on city plans and was found in the field although it is not listed by the MDC.

We estimate the total rated capacity of all public connections to be about 456.58 mgd as shown on Table 25. The rated capacity of the special connections is estimated to be 36.17 mgd. Thus the total estimated rated capacity is 492.75 mgd. This compares with an initial demand-capacity of 493.92 mgd as computed by the MDC and is considered to be a reasonable verification of the MDC figure.

We have not evaluated prorated demand-capacity (adjusted from initial demand-capacity based on capacity of downstream interceptor) figures calculated by the MDC or estimated present sewage flows in each connection individually. Quantities of storm water and tide water entering the existing city sewerage system are impossible to estimate with any reasonable degree of accuracy. Storm water enters the system frequently, surcharging portions of it, at high rates for short periods of time. Tide water, however, enters during each tide cycle through defective tide gates and other facilities as evidenced by observations. Connection capacities required for all flows entering from these sources would be much greater that for average dry weather flows of sewage alone. Therefore, we consider that comparison of prorated demand-capacity figures for each connection with estimated 1967 flows of dry weather sewage would have little meaning.

We have estimated the average and peak rates of daily dry weather sewage flow which are expected to reach the MDC sewerage system from all Boston connections for the years 1967, 1995 and 2020 as shown in Table 11, Chapter V. We estimate that if all tide water and storm water is excluded from connections to the MDC sewerage system, the average daily dry weather flow of sewage from the entire city will be about 151 mgd in 1967, 204 mgd in 1995 and 261 mgd in 2020 including Main Drainage System connections. Estimated peak rates for years 1967, 1995 and 2020 are 282, 386, and 498 mgd respectively. Present total prorated demand-capacity for the 218 public and special connections has been calculated by the MDC to be about 419 mgd with four Main Drainage System connections included (CDM Connection Nos. 136, 137, 138 and 139). At this time CDM Connection Nos. 136 and 137 only have been placed in operation.

It will be advantageous for the city to make improvements to existing outlets and appurtenant facilities as recommended in Chapters VIII and IX, and in addition, carry out preventive maintenance to keep tide water and excessive storm flows from entering its sewerage system and passing through MDC connections. If these improvements are made, the required total capacity of all Boston connections to the MDC sewerage system, based on the estimated peak dry weather sewage flows indicated above, would be less than the total prorated demand-capacity of 419 mgd until about the year 2000. Since the design of facilities recommended for the Initial and Future Construction Programs are based upon estimated peak flows for the year 2020, we consider that charges to the city, for both public and special connections, based on a total prorated demand-capacity of about 419 mgd, are reasonable.

There are, however, two connection changes which will result from the recommended Initial Construction Program. The first change is that CDM Connection No. 138 (a 36-in x 54-in connection) will be abandoned in conjunction with the abandonment of the South Boston Interceptor (South Branch). This connection will be replaced by a proposed 60-in dry weather connection to the MDC Columbus Park Connection serving the proposed South Boston Pollution Control Conduit. The second change is that CDM Connection No. 139 will be reduced from a 126-in diameter connection to a 72-in and a 36-in connection in conjunction with the proposed relocation of the Boston Main Interceptor. The proposed Main Interceptor will enter the existing MDC Columbus Park Connection through a 96-in connection. Flows from the existing Dorchester Interceptor will continue to enter the Columbus Park Connection as at present.

In addition to the above changes, we recommend that the existing 54-in x 56-in modified circle brick connection to the Dorchester High Level Sewer at River Street (CDM Connection No. 135) be replaced for several hundred feet with a 36-in diameter pipe connection which will be adequate for estimated year 2020 peak dry weather flows. The original design of the 54-in x 56-in connection contemplated the dry weather flow of sewage from a considerable tributary area to the north which was never connected and for which area there are now no plans for connection.

If all connection changes are made as described above, the total rated capacity of the connections will increase by about 2 mgd. If only those changes are made which are necessitated by the Initial Construction Program the increase would be about 14 mgd. We recommend that the Dorchester High Level Sewer connection be changed in order to keep the estimated rated capacity increase to a minimum.

Detailed study of each connection to the MDC sewerage system would no doubt indicate connections which could be increased or decreased in capacity to serve tributary areas. In general, however, as stated above, the total capacity on which Boston's share of the MDC assessment is based, appears reasonable.

Effects of the MDC Construction Program

The primary purpose of the MDC construction program, as authorized by legislative acts described in Appendix A of Vol. 2 and Chapter II, is to provide "for sewage disposal needs in the north and south metropolitan sewerage districts and the Boston main drainage system....".

While most of the projects included in this program have now been completed or are nearing completion, only a partial diversion of flows from the Boston Main Drainage System has so far taken place. In May 1967, the diversion of flows from the West Side Interceptor and Stony Brook Interceptor at Tremont and Camden Streets was initiated via the MDC Boston Main Drainage Relief Sewer. It is reported that shortly after diversion was started excessive quantities of sewage solids and debris entered the MDC Ward Street Headworks. In addition, daily quantities of flow reported to have been diverted through the connection were greatly in excess of estimated present average daily dry weather flows and also in excess of the pump capacity available at Deer Island at that time requiring a reduction in the flow diverted. Since the weather during this period was relatively dry, it is reasonable to assume that flows in excess of estimated dry weather flows resulted from the entrance of tide water through outlets as discussed in Chapters III and VIII.

After the diversion had been functioning for several weeks, we made a series of gagings to determine if water levels in the West Side Interceptor had been reduced below those observed in August 1966, as discussed in Chapter III. Allowing for possible differences in pumping rates at the Calf Pasture Pumping Station and Union Park Street Pumping Station for the two periods, no significant changes in water levels was observed. As a result, the diversion of flows through the MDC Boston Main Drainage Relief Sewer appears to have no appreciable effect on the surcharging of the West Side Interceptor and probably the remainder of the Boston Main Drainage System.

It is reported that the MDC and BRA are planning work on tide gates along the existing East Side Interceptor. If this work is accomplished in a manner similar to that described in Chapter VIII and Appendix D of Vol. 2, it is expected that the intrusion of tide water from that source may be greatly reduced. However, we would expect frequent surcharging of the Boston Main Drainage System to continue because of outlet conditions and probable structural conditions of the West Side Interceptor, Boston Main Interceptor, South Boston Interceptor and Dorchester Interceptor until the facilities recommended in the Initial and Future Construction Programs are placed into operation.

At such time as tide water is eliminated from the Boston Main Drainage System, the facilities built as part of the MDC construction program, when in full operation, will receive all dry weather flows of sewage from Boston. This will, of course, tend to improve somewhat the quality of waters in Boston Harbor and adjacent waters and reduce surcharging conditions during periods of extended dry weather. During wet weather and for periods of time after storms surcharging conditions will still occur, and discharges of mixed sewage and storm water will continue to occur as discussed herein.

The MDC Storm Water Detention Tank at B. U. Bridge is planned for construction as a demonstration of the effectiveness of the chlorination of overflows of mixed sewage and storm water. As discussed in Chapter VII, we do not consider that this type of facility will provide an economic or practical solution to the problem of mixed sewage and storm water overflows in the Boston region.

As a result of the above considerations, little or no improvement of water quality in Boston Harbor and adjacent waters may be expected until the proposed Deep Tunnel Plan becomes a reality.

XI POLLUTION ABATEMENT AUTHORITY OF GOVERNMENTAL AGENCIES

General

The abatement of pollution of Boston Harbor and adjacent waters falls within the authority of many governmental agencies. The authorities and responsibilities of the various agencies frequently overlap and centralized authority is lacking. The authorities and responsibilities of these various agencies is discussed briefly hereinafter.

Federal Agencies

Department of the Interior

The Department of the Interior is the Federal agency with the greatest overall responsibilities in the field of water resources. These responsibilities were greatly augmented in May, 1966 by the transfer to the Department of the Interior of the Federal Water Pollution Control Administration (FWPCA) from the Department of Health, Education and Welfare.

The FWPCA administers a national program to enhance the quality and value of the nation's water resources and to otherwise assure the fulfillment of a national policy for the prevention, control, and abatement of water pollution. Among the major functions of the FWPCA are:

1. The development or conduct of comprehensive and special programs designed to eliminate or reduce the pollution of interstate waters and their tributaries.

2. The encouragement and cooperative support of state enforcement authorities and exercise of Federal authority as required to abate pollution of interstate or navigable waters.

3. The encouragement of the development and enactment of improved State laws and the development of interstate compacts.

4. The conduct, promotion, and support of research investigations experimentation, and demonstrations, including the publication of related results and information.

5. The awarding of grants for the construction of municipal waste treatment works as discussed in Chapter IX.

6. The awarding of grants and utilization of contract authority to assist in demonstrating new or improved methods for controlling pollutional waste discharges from combined sewer systems.

In addition to the FWPCA the Department of the Interior also has within its jurisdiction the United States Fish and Wildlife Service. This Service, in promoting fisheries resources, has a leading interest in water pollution control, water supply projects, and determination of benefits from the standpoint of fish and wildlife.

Department of Housing and Urban Development

Executive Order No. 11288, Prevention, Control and Abatement of Water Pollution by Federal Activities, directed the Department of Housing and Urban Development (HUD) to take steps to reduce water pollution to the lowest level practicable and to assure that pollution control standards are met on a continuing basis. HUD is responsible for taking advantage of urban renewal project opportunities to advance national efforts to reduce and control the pollution of rivers and other watercourses, especially in and around urban centers. Specifically, this Department is required to give consideration to development of sewer systems to serve urban renewal areas which will, to the maximum extent feasible, provide for effective control of sewage and storm water. Federal assistance for water pollution control under the HUD program is discussed in more detail in Chapter IX.

Department of Health, Education and Welfare

The U. S. Public Health Service retained some responsibility for water pollution control after the transfer of the FWPCA to the Interior Department as discussed above. The Public Health Service continues to have broad responsibilities for environmental health activities, including conduct of research, techniques and methods of control, development and utilization of manpower, and administration of regulations for public health if it is affected by environmental pollution.

Department of Commerce

The Economic Development Administration was established under the Secretary of Commerce by the Public Works and Economic Development Act of 1965. This Act provides grants for public works including water and sewer facilities when they contribute to the economic development of eligible depressed areas. This program is discussed in greater detail in Chapter IX.

Department of Defense

The Secretary of the Army is responsible for the civil works program of the Corps of Engineers, which includes such activities as waterways improvements, flood control and information concerning flood hazards, water supply, river flow regulation, hydroelectric power, shore protection, recreation, regulation use of navigable waterways. In 1965 the Corps of Engineers was authorized by Congress to conduct a comprehensive water and related land resources investigation of the Charles River watershed. The basic objective of this study is the formulation of a plan of development which will serve as a guide for the best use or combination of uses of water and related land resources in the watershed to meet foreseeable short and long term needs. Included in this study is consideration of present and the future requirements for water supply, flood control, navigation, water quality control, recreation, fish and wildlife, and other purposes requiring development of water and related land resources. This study is underway at the present time and is discussed briefly in conjunction with proposed improvements in the Stony Brook System in Chapter VIII.

Among other duties of the Corps of Engineers is the enforcement of Federal and international treaty requirements regarding pollution of harbor and ocean waters. It also handles all litigation regarding oil, pollution and dumping refuse into the harbor.

State Agencies

Department of Natural Resources

In 1966, the Division of Water Pollution Control was established within the Department of Natural Resources. The Division is authorized to implement, administer and enforce water pollution control in Massachusetts in conjunction with the other water management programs administered by the Department of Natural Resources. It has established standards of water quality for Massachusetts waters and has classified these waters as discussed in Chapter VI. It is also responsible for determining the eligibility for financial assistance of water pollution control projects as discussed in Chapter IX.

Department of Public Health

The Massachusetts Department of Public Health (DPH), under Chapter 111 of the General Laws of Massachusetts, is to "take cognizance of the interests, life, health, comfort and convenience, among the citizens of the commonwealth", including the conduct of "sanitary investigations and investigations as to the cause of disease.....". It is concerned with the effect of water pollution on the public health, particularly in connection with bathing and shellfish-taking. The Department has emergency powers to close shellfish areas in the event that analyses show pollution.

Department of Public Works

The Massachusetts Department of Public Works (DPW), under Chapter 91 of the General Laws of Massachusetts, is responsible for the "general care and supervision of the harbor and tide waters within the Commonwealth...". It is responsible for planning and carrying out State engineering projects regarding shore protection, beaches, piers, and other improvements in harbors and other coastal and inland waters. It is also authorized to prevent the dumping of debris in harbors and to take action against oil pollution. These duties of the DPW are administered through its Division of Waterways.

Metropolitan District Commission

The MDC has the responsibility for building, operating, and maintaining a comprehensive sewerage system serving the Boston metropolitan area. It is authorized to receive the sewage from municipal sewer systems connected to it and to make assessments against these municipalities as discussed in Chapter X.

Metropolitan Area Planning Council

The Metropolitan Area Planning Council (MAPC) is responsible for providing a comprehensive, far reaching and effective metropolitan planning effort. It is conducting a regional public services and facilities study which would provide a regional plan and development program to assure adequate water and sewer facilities. The first phase of this study, consisting of an inventory of existing facilities, has been completed by Camp, Dresser &

McKee. The MAPC has selected Camp, Dresser & McKee to perform the second phase which consists of the comprehensive plan, as soon as funds are available.

Massachusetts Port Authority

The Massachusetts Port Authority (MPA) within its area of Boston Harbor, has powers similar to those of the State Department of Public Works. MPA projects are not subject to the DPW's control. The MPA has jurisdication over marine terminal facilities and Logan International Airport in addition to other projects within waters under its control.

City of Boston Agencies

Public Works Department

The City of Boston Public Works Department through its Sewerage Division is responsible for constructing, maintaining and operating City sewerage facilities.

Boston Redevelopment Authority

The BRA is responsible for providing adequate sewerage facilities as an integral part of its urban renewal activities within the City.

Health Department

The Boston Health Department is responsible for enforcing all regulations affecting the health of persons in the city. This includes the closing of beaches or shellfish-taking areas, in conjunction with the Massachusetts Department of Public Health, in the event that pollution is determined to exist.

Coordination of Activities

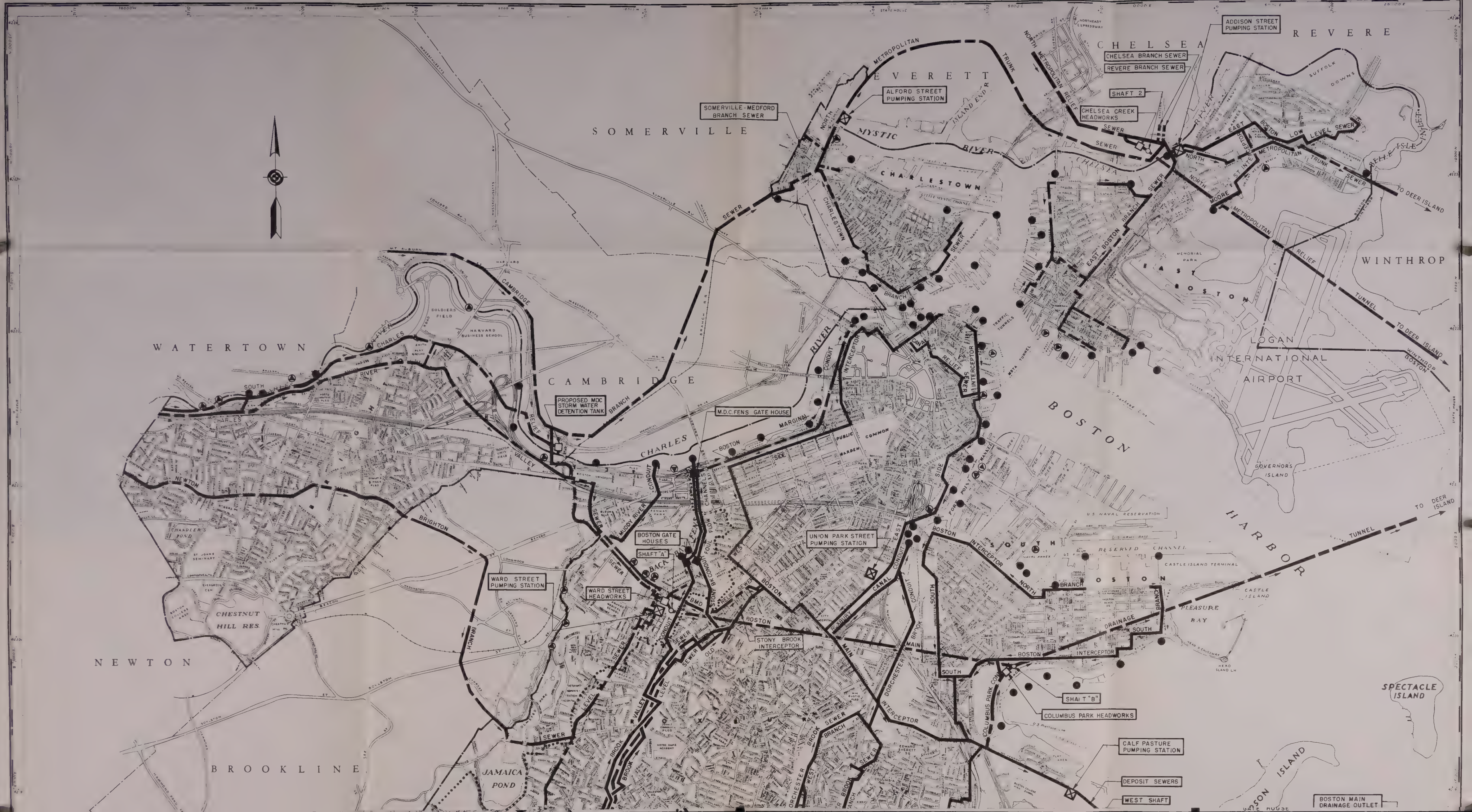
Despite the activities of all the agencies described above as well as others which are affected by pollution of the waters of Boston Harbor and adjacent waters, constant pollution of the waters is still taking place as discussed hereinbefore. Many of these agencies are plagued with shortages of manpower and money. Responsibilities are divided with the result that no one agency considers itself free to take decisive action to clean up the harbor and adjacent waters.

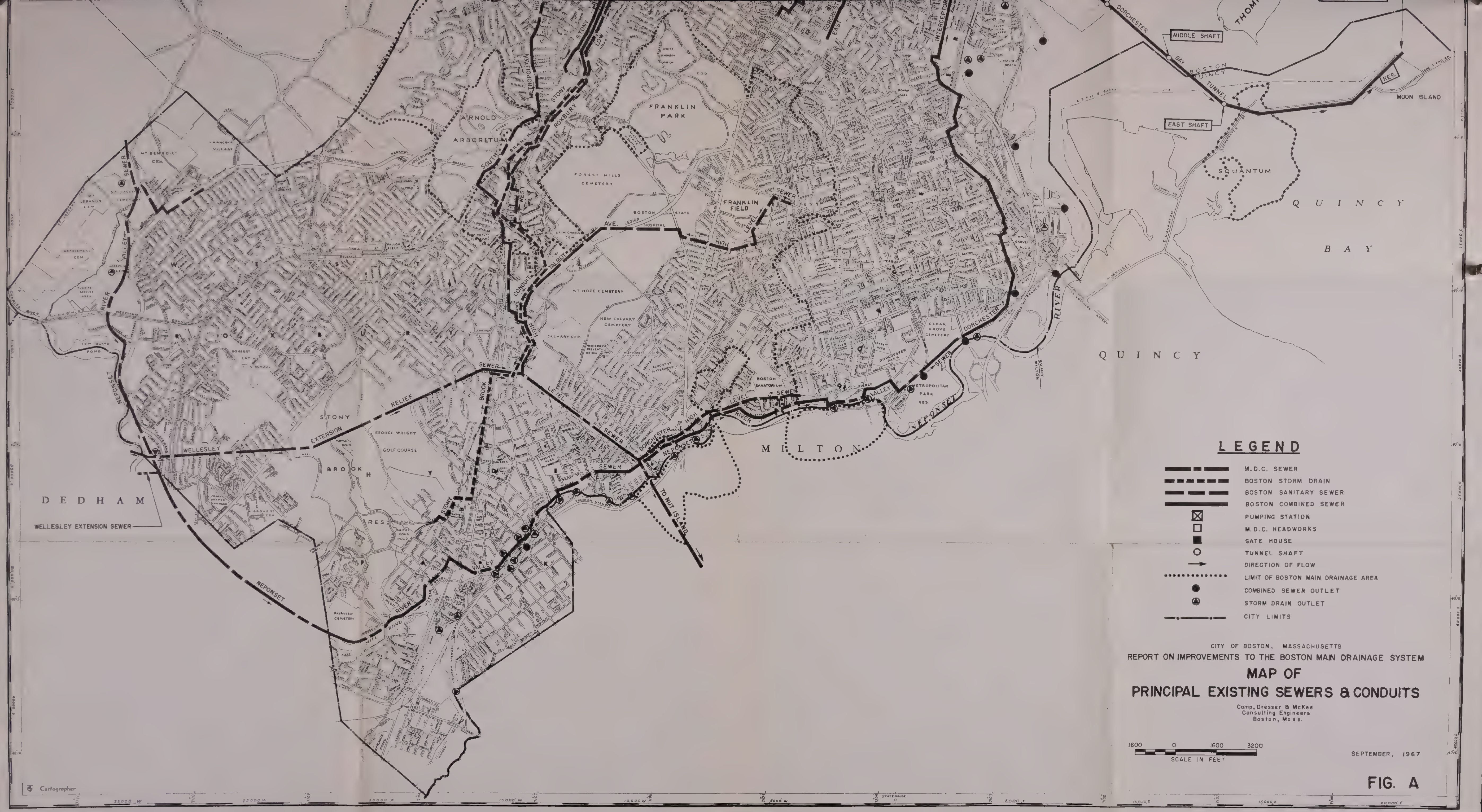
The most ambitious plan to date to coordinate and streamline the effort of all the agencies was the creation of the Harbor Pollution Committee three years ago. This committee was initiated by the Massachusetts Port Authority. Other members of the committee come from the various agencies having control over the harbor.

Recently it was proposed that a Boston Harbor Development Commission be created to serve as a coordinator for the various Federal, State and local agencies involved in harbor development and pollution control.

A spokesman for the Metropolitan Area Planning Council was quoted as having stated "the council finds the most crippling aspect of the harbor situation is the overlapping jurisdiction".

It is our opinion that either a new or existing commission be granted the authority to coordinate and direct the pollution control activities of all affected agencies and eliminate the pollution of Boston Harbor and adjacent waters.


ADDISON STREET PUMPING STATION
CHELSEA BRANCH SEWER
REVERE BRANCH SEWER
SHAFT 2
CHELSEA CREEK HEADWORKS
ALFORD STREET PUMPING STATION
SOMERVILLE-MEDFORD BRANCH SEWER
PROPOSED MDC STORM WATER DETENTION TANK
M.D.C. FENS GATE HOUSE
BOSTON GATE HOUSES
SHAFT "A"
WARD STREET PUMPING STATION
WARD STREET HEADWORKS
UNION PARK STREET PUMPING STATION
STONY BROOK INTERCEPTOR
SHAFT "B"
COLUMBUS PARK HEADWORKS
CALF PASTURE PUMPING STATION
DEPOSIT SEWERS
WEST SHAFT
BOSTON MAIN DRAINAGE OUTLET
CHELSEA
REVERE
EVERETT
SOMERVILLE
CHARLESTOWN
EAST BOSTON
WINTHROP
LOGAN INTERNATIONAL AIRPORT
WATERTOWN
CAMBRIDGE
BOSTON
SOUTH BOSTON
BOSTON HARBOR
NEWTON
BROOKLINE
CHESTNUT HILL RES.
JAMAICA POND
SPECTACLE ISLAND
GOVERNOR'S ISLAND
CASTLE ISLAND
PLEASURE BAY
SUFFOLK DOWNS
BELLE ISLE INLET
MYSTIC RIVER
CHARLES RIVER
CHELSEA RIVER
NORTH METROPOLITAN TRUNK SEWER
NORTH METROPOLITAN RELIEF SEWER
METROPOLITAN RELIEF TUNNEL
TO DEER ISLAND
BOSTON LOW LEVEL SEWER
EAST BOSTON BRANCH
CHARLESTOWN BRANCH
CAMBRIDGE BRANCH SEWER
CANAL RELIEF SEWER
RIVER CONDUIT
INTERCEPTOR
MARGINAL CONDUIT
BOSTON MARGINAL CONDUIT
SOUTH CHARLES RIVER VALLEY SEWER
NEWTON
BRIGHTON BRANCH
MUDDY RIVER CONDUIT
STONY BROOK CONDUIT
FOUL FLOW CHANNELS
HIGH LEVEL SEWER
VALLEY SEWER
BOSTON MAIN DRAINAGE
BMD
EAST SIDE INTERCEPTOR
CANAL CONDUIT
DORCHESTER BROOK CONDUIT
BOSTON NORTH BRANCH INTERCEPTOR
SOUTH BRANCH
SOUTH BOSTON INTERCEPTOR
DRAINAGE
DORCHESTER BROOK
WEST BRANCH
INTERCEPTOR
COLUMBUS PARK CONDUIT
TUNNEL
MEMORIAL PARK
U.S. NAVAL RESERVATION
RESERVED CHANNEL
CASTLE ISLAND TERMINAL
SOLDIERS FIELD
HARVARD BUSINESS SCHOOL
PUBLIC GARDEN
COMMON
BACK BAY FENS
ST. JOHNS SEMINARY
CHANDLER'S POND
NORTHEAST EXPRESSWAY
TRAFFIC TUNNELS
HEAD ISLAND
MOON ISLAND



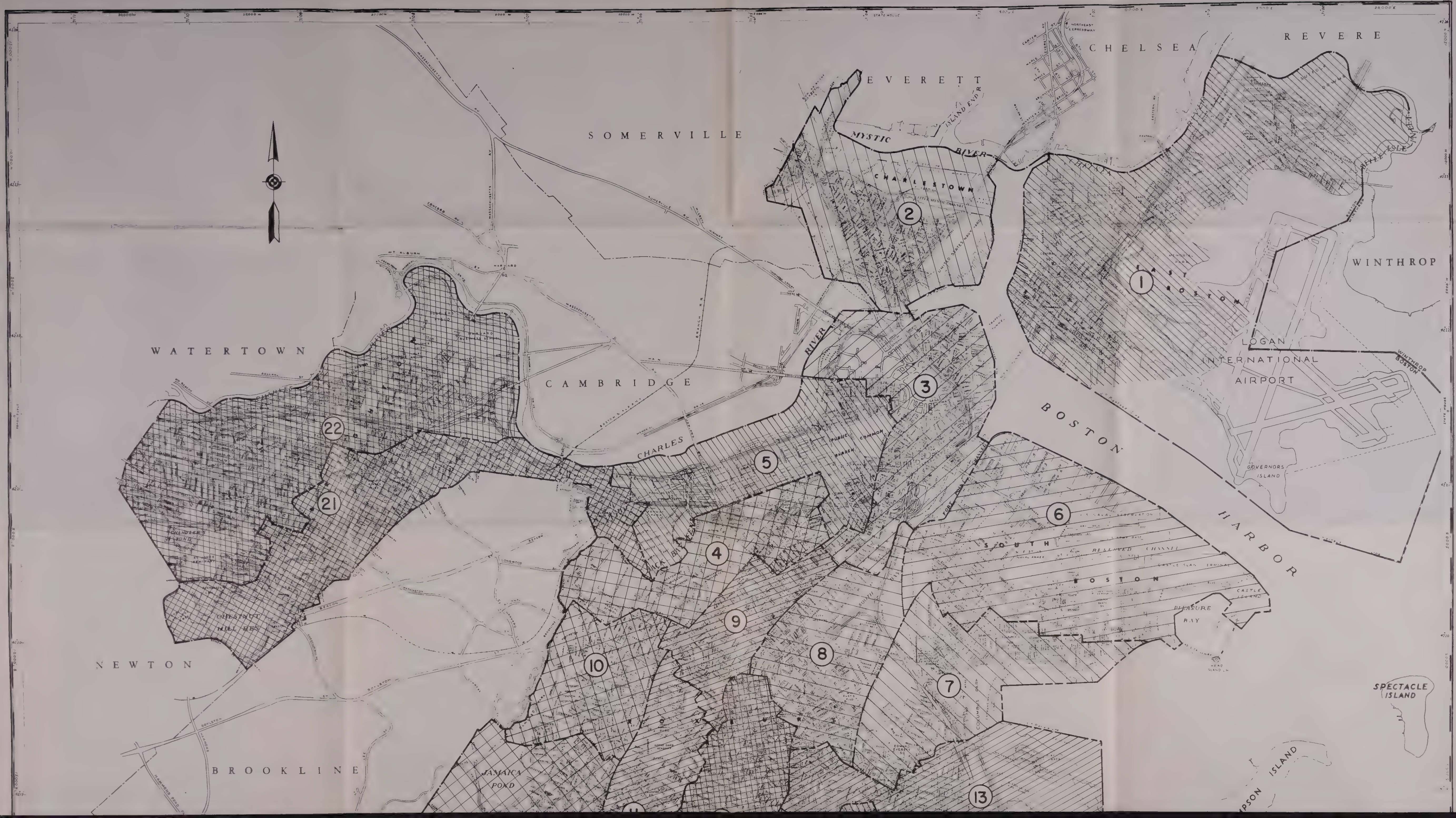
CITY OF BOSTON, MASSACHUSETTS
REPORT ON IMPROVEMENTS TO THE BOSTON MAIN DRAINAGE SYSTEM

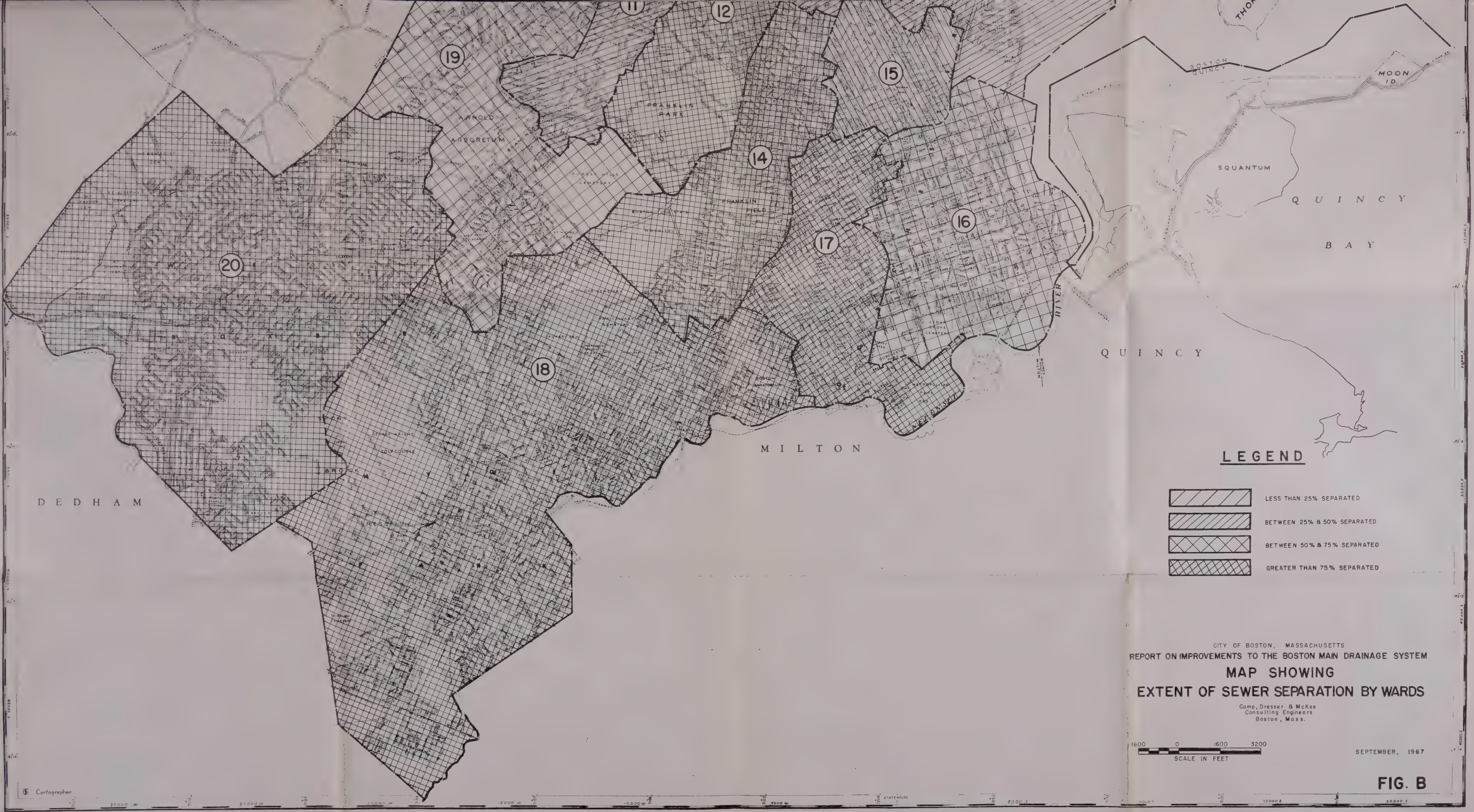
MAP OF
PRINCIPAL EXISTING SEWERS & CONDUITS

Camp, Dresser & McKee
Consulting Engineers
Boston, Mass.

SEPTEMBER, 1967

FIG. A


SOMERVILLE
EVERETT
CHELSEA
REVERE
MYSTIC
RIVER
ISLAND END R.
NORTHEAST EXPRESSWAY
CHARLESTOWN
2
1
EAST BOSTON
WINTHROP
LOGAN INTERNATIONAL AIRPORT
WINTHROP BOSTON
GOVERNORS ISLAND
WATERTOWN
CAMBRIDGE
MT. AUBURN
HARVARD SQ.
RIVER
3
BOSTON
HARBOR
22
CHARLES
5
PUBLIC GARDEN
COMMON
21
CHANDLERS POND
6
SOUTH BOSTON
RESERVED CHANNEL
CASTLE ISLAND
PLEASURE BAY
4
BACK BAY
CHESTNUT HILL RES.
9
8
10
7
NEWTON
SPECTACLE ISLAND
ROXBURY
BROOKLINE
JAMAICA POND
PSON ISLAND
13



CITY OF BOSTON, MASSACHUSETTS

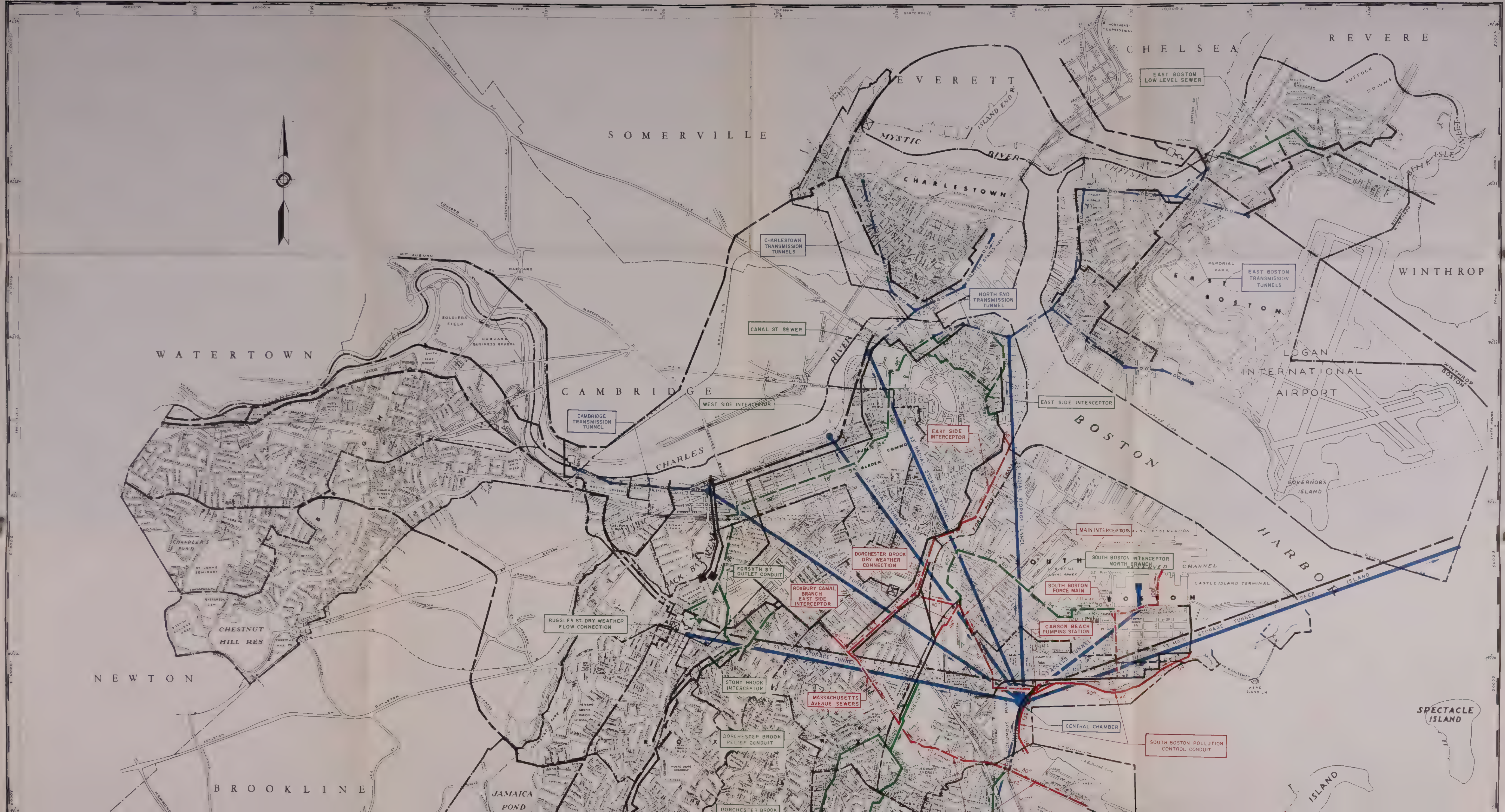
REPORT ON IMPROVEMENTS TO THE BOSTON MAIN DRAINAGE SYSTEM

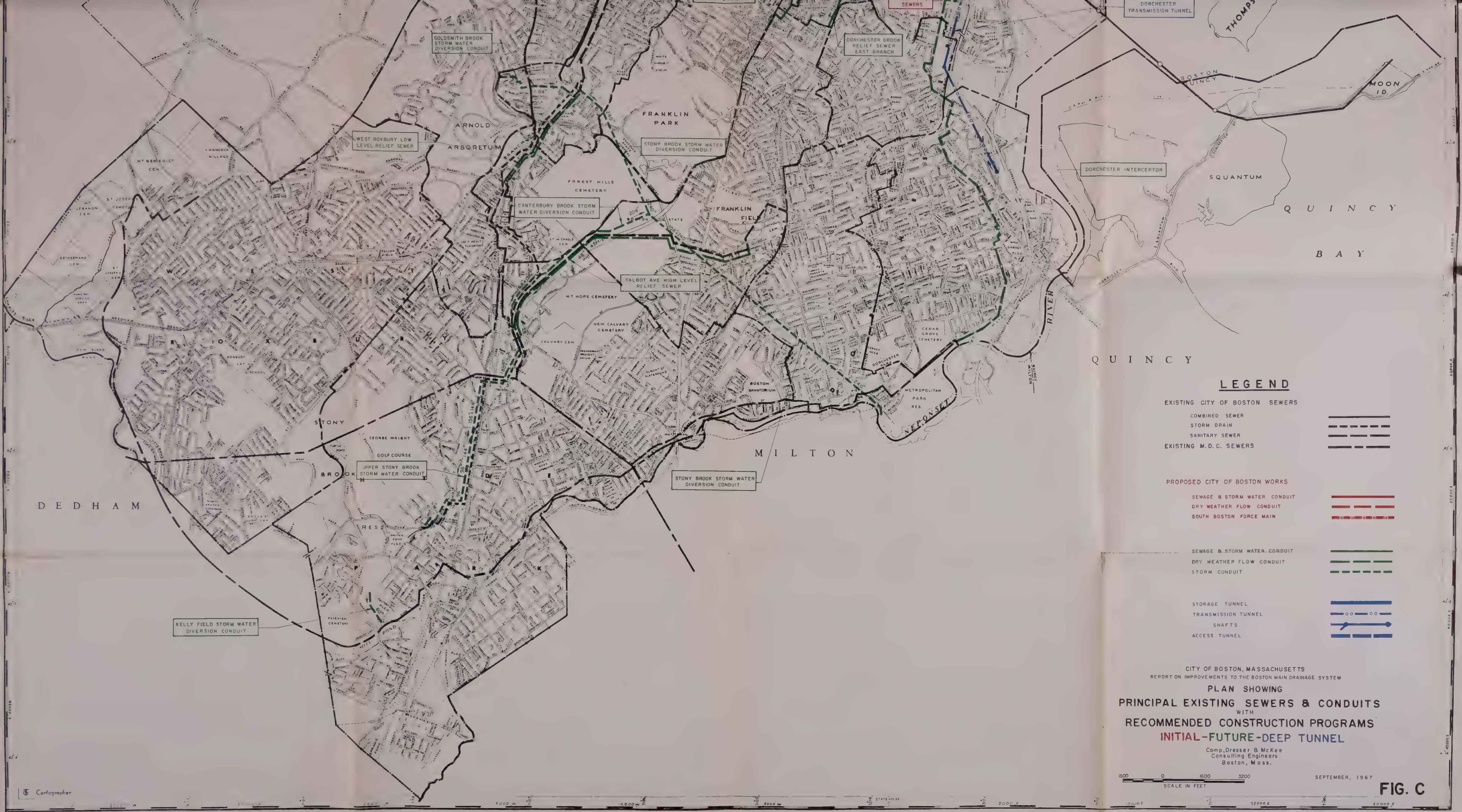
MAP SHOWING
EXTENT OF SEWER SEPARATION BY WARDS

Camp, Dresser & McKee
Consulting Engineers
Boston, Mass.

SEPTEMBER, 1967

FIG. B


SOMERVILLE
EVERETT
CHELSEA
REVERE
WINTHROP
WATERTOWN
CAMBRIDGE
NEWTON
BROOKLINE
CHARLESTOWN
EAST BOSTON
SOUTH BOSTON
BACK BAY
MYSTIC RIVER
CHARLES RIVER
BOSTON HARBOR
LOGAN INTERNATIONAL AIRPORT
GOVERNORS ISLAND
SPECTACLE ISLAND
CHESTNUT HILL RES
CHANDLER'S POND
JAMAICA POND
SUFFOLK DOWNS
MEMORIAL PARK
CHANNEL
CASTLE ISLAND TERMINAL
EAST BOSTON LOW LEVEL SEWER
CHARLESTOWN TRANSMISSION TUNNELS
NORTH END TRANSMISSION TUNNEL
EAST BOSTON TRANSMISSION TUNNELS
CANAL ST SEWER
CAMBRIDGE TRANSMISSION TUNNEL
WEST SIDE INTERCEPTOR
EAST SIDE INTERCEPTOR
EAST SIDE INTERCEPTOR
MAIN INTERCEPTOR
SOUTH BOSTON INTERCEPTOR NORTH BRANCH
DORCHESTER BROOK DRY WEATHER CONNECTION
FORSYTH ST. OUTLET CONDUIT
ROXBURY CANAL BRANCH EAST SIDE INTERCEPTOR
SOUTH BOSTON FORCE MAIN
CARSON BEACH PUMPING STATION
RUGGLES ST. DRY WEATHER FLOW CONNECTION
STONY BROOK INTERCEPTOR
MASSACHUSETTS AVENUE SEWERS
DORCHESTER BROOK RELIEF CONDUIT
DORCHESTER BROOK
CENTRAL CHAMBER
SOUTH BOSTON POLLUTION CONTROL CONDUIT
33' RADIAL STORAGE TUNNEL
33' MAIN STORAGE TUNNEL
ACCESS TUNNEL
DEER ISLAND
FORT POINT CHANNEL
PUBLIC GARDEN
COMMON
ISLAND



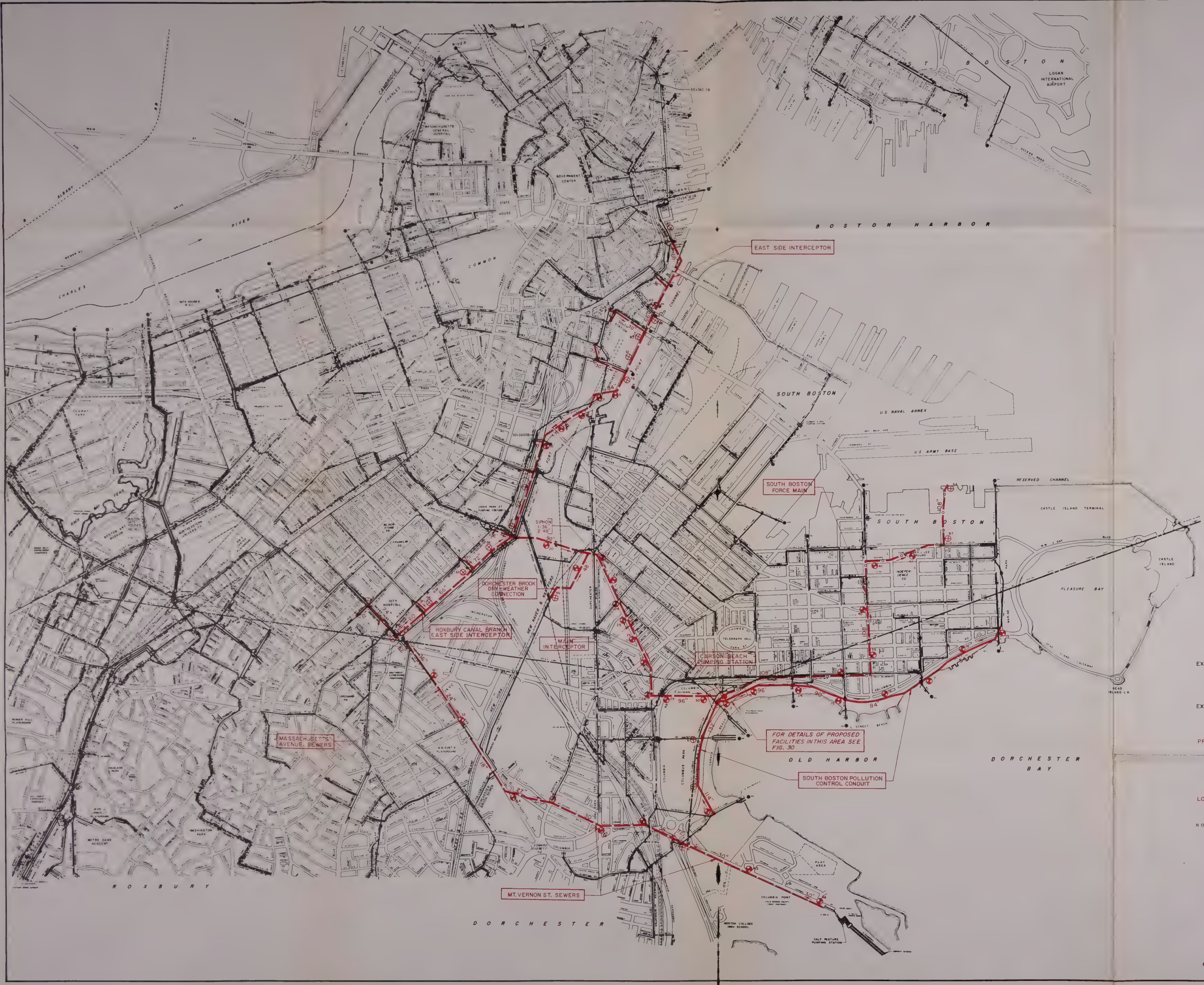
CITY OF BOSTON, MASSACHUSETTS
REPORT ON IMPROVEMENTS TO THE BOSTON MAIN DRAINAGE SYSTEM

PLAN SHOWING
PRINCIPAL EXISTING SEWERS & CONDUITS
WITH
RECOMMENDED CONSTRUCTION PROGRAMS
INITIAL-FUTURE-DEEP TUNNEL

Camp, Dresser & McKee
Consulting Engineers
Boston, Mass.

SEPTEMBER, 1967

FIG. C



LEGEND

EXISTING CITY OF BOSTON SEWERS

COMBINED SEWER
STORM DRAIN
SANITARY SEWER

EXISTING M.D.C. SEWERS

COMPLETE LEGEND FOR EXISTING SEWERAGE SYSTEM IS SHOWN ON FIG. 4 APPENDIX B, VOL 2

PROPOSED CITY OF BOSTON WORKS

SEWAGE & STORM WATER CONDUIT
DRY WEATHER FLOW CONDUIT
OVERFLOW INTERCEPTION CHAMBER

LOCATION & NUMBER OF BORINGS

CDM BORING
BORING BY OTHERS WITH CDM NUMBER

NOTES:

1. FOR BORING LOGS SEE APPENDIX G, VOL. 2
2. FOR PROFILES SEE CHAPTER VIII, VOL. I
3. IMPROVEMENTS TO EXISTING COMBINED SEWER OUTLETS. ARE DESCRIBED IN CHAPTER IX

CITY OF BOSTON, MASSACHUSETTS
REPORT ON IMPROVEMENTS TO THE BOSTON MAIN DRAINAGE SYSTEM
PLAN SHOWING
EXISTING SEWERAGE SYSTEM
WITH
RECOMMENDED INITIAL CONSTRUCTION PROGRAM
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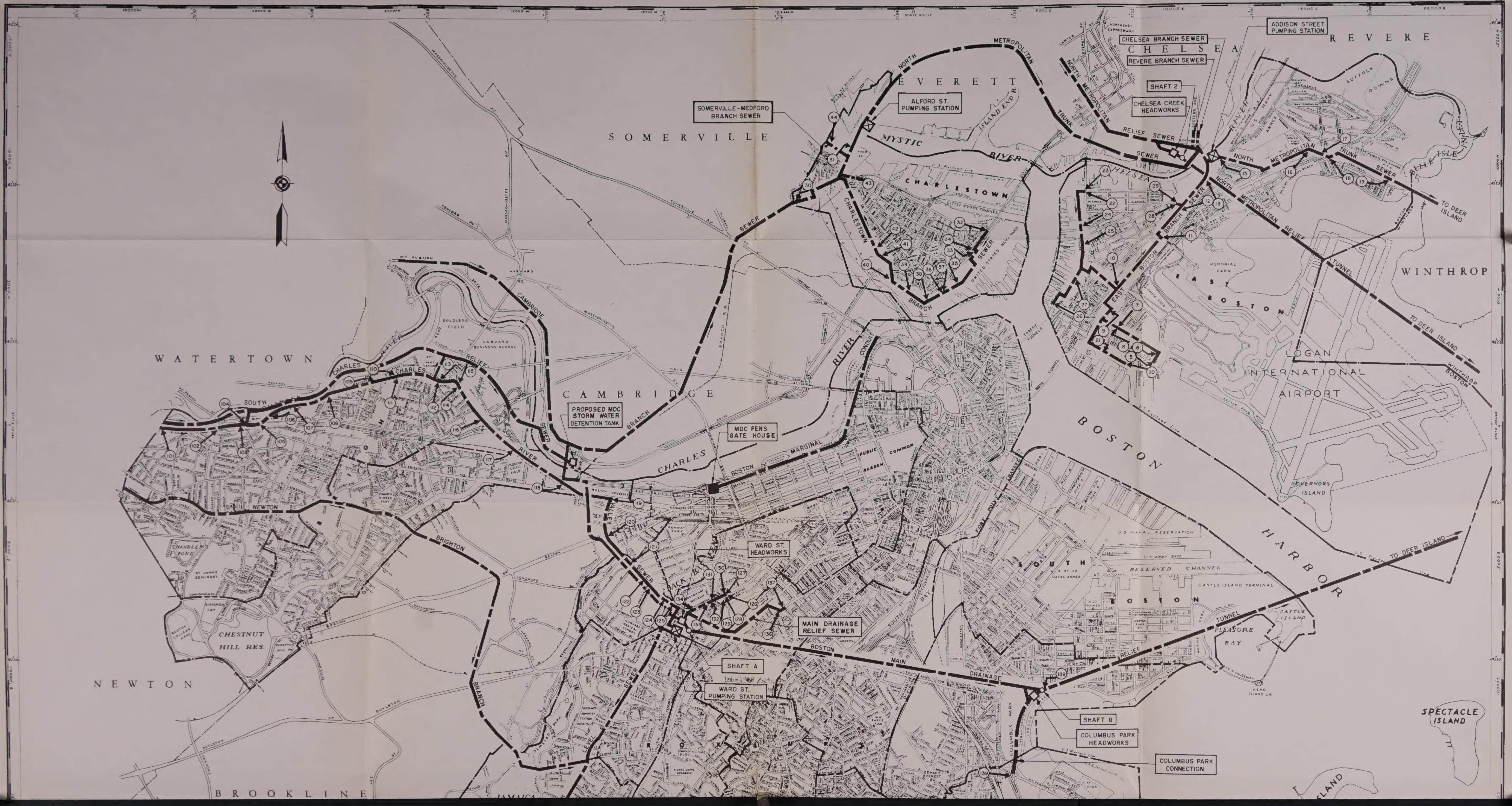
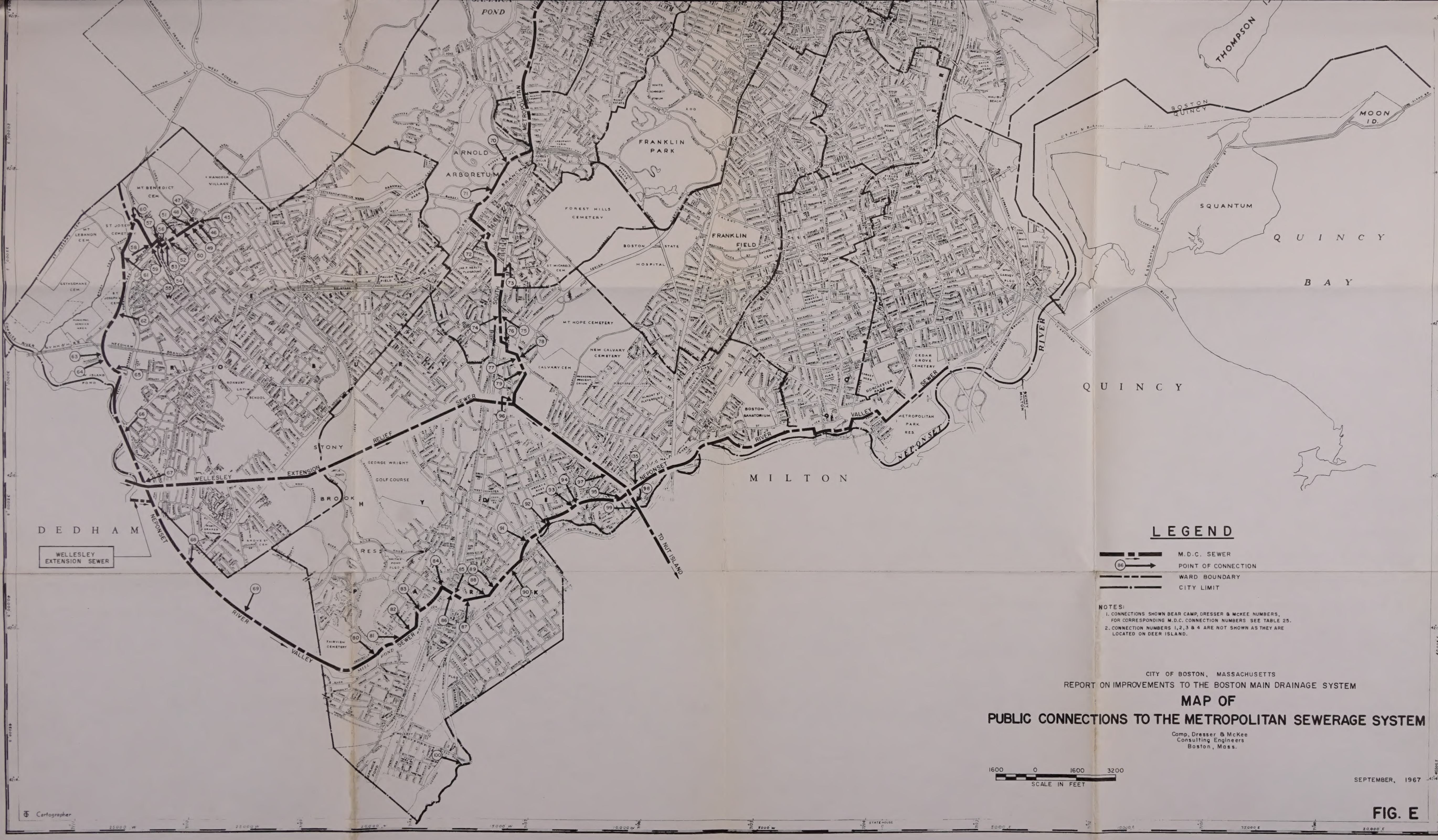
800 0 800
SCALE IN FEET

SEPTEMBER, 1967

FIG. D


ADDISON STREET PUMPING STATION
CHELSEA BRANCH SEWER
REVERE BRANCH SEWER
SHAFT 2
CHELSEA CREEK HEADWORKS
SOMERVILLE-MEDFORD BRANCH SEWER
ALFORD ST. PUMPING STATION
PROPOSED MDC STORM WATER DETENTION TANK
MDC FENS GATE HOUSE
WARD ST. HEADWORKS
MAIN DRAINAGE RELIEF SEWER
SHAFT A
WARD ST. PUMPING STATION
SHAFT B
COLUMBUS PARK HEADWORKS
COLUMBUS PARK CONNECTION
SOMERVILLE
EVERETT
CHELSEA
REVERE
WINTHROP
CAMBRIDGE
WATERTOWN
NEWTON
BROOKLINE
CHARLESTOWN
EAST BOSTON
SOUTH BOSTON
BOSTON HARBOR
LOGAN INTERNATIONAL AIRPORT
GOVERNORS ISLAND
CASTLE ISLAND
PLEASURE BAY
SPECTACLE ISLAND
CHESTNUT HILL RES.
CHANDLER'S POND
MYSTIC RIVER
CHARLES RIVER
NORTH METROPOLITAN TRUNK SEWER
NORTH METROPOLITAN RELIEF SEWER
NORTH METROPOLITAN RELIEF TUNNEL
CHARLESTOWN BRANCH SEWER
EAST BOSTON BRANCH SEWER
CAMBRIDGE BRANCH SEWER
CHARLES RIVER RELIEF SEWER
SOUTH CHARLES RELIEF
CHARLES RIVER CONDUIT
BOSTON MARGINAL CONDUIT
BOSTON MAIN DRAINAGE TUNNEL
BOSTON MAIN DRAINAGE RELIEF TUNNEL
BRIGHTON BRANCH
NEWTON
VALLEY SEWER
BACK BAY FENS
FORT POINT CHANNEL
RESERVED CHANNEL
CASTLE ISLAND TERMINAL
U.S. NAVAL RESERVATION
U.S. ARMY BASE
SOLDIERS FIELD
HARVARD BUSINESS SCHOOL
PUBLIC GARDEN
COMMON
MEMORIAL PARK
SUFFOLK DOWNS
BELLE ISLE INLET
TO DEER ISLAND
TO DEER ISLAND
TO DEER ISLAND
TO DEER ISLAND
STATE HOUSE



LEGEND

▬ ▪ ▬	M.D.C. SEWER
(86)→	POINT OF CONNECTION
▬ - - ▬	WARD BOUNDARY
—•—	CITY LIMIT

NOTES:
1. CONNECTIONS SHOWN BEAR CAMP, DRESSER & McKEE NUMBERS, FOR CORRESPONDING M.D.C. CONNECTION NUMBERS SEE TABLE 25.
2. CONNECTION NUMBERS 1,2,3 & 4 ARE NOT SHOWN AS THEY ARE LOCATED ON DEER ISLAND.

CITY OF BOSTON, MASSACHUSETTS
REPORT ON IMPROVEMENTS TO THE BOSTON MAIN DRAINAGE SYSTEM

MAP OF
PUBLIC CONNECTIONS TO THE METROPOLITAN SEWERAGE SYSTEM

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1600 0 1600 3200
SCALE IN FEET

SEPTEMBER, 1967

FIG. E

ACCOPRESS®

25071	BLACK
25072	LIGHT BLUE
25073	DARK BLUE
25074	LIGHT GRAY
25075	LIGHT GREEN
25076	DARK GREEN
25077	TANGERINE
25078	RED
25079	EXECUTIVE RED
25070	YELLOW

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